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Recent Developments In Snow Removal

Growth of popular approval of expenditures therefor. Drift prevention by snow fences and evergreen wind-breaks. Rapidly and slowly moving vehicles in snow removal.

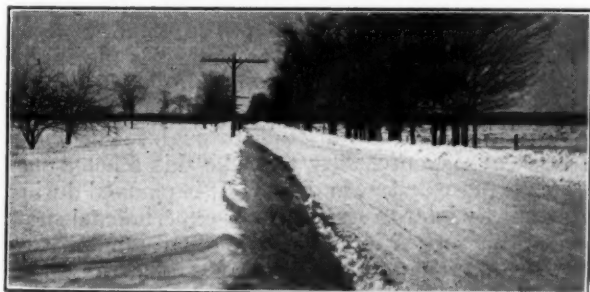
By V. R. Burton*

A few years ago, when snow removal from country highways was first begun, it was not looked on with favor by a great many residents in the communities through which the work was being done. Bitter opposition of many farmers along the route was encountered, and in heavy snow territory it was freely predicted that this foolish waste of public funds would come to a speedy end. It was claimed that the removal of the snow would ruin the road surface for sleigh traffic, and that automobile traffic would be able to use it only for a small proportion of the time. The idea that if the building of a road were justified at all it should be kept passable the year round, had not yet occurred to many people.

Snow removal in the territory in which the op-

has become quite a common practice for the farmer to store his automobile with a neighbor on the main road and drive from his house to the main road, leaving the horses in the garage where the automobile is stored, using the automobile for his trip into town and then driving the horses back over the side road. In some cases the building of a garage on the main road has been resorted to, to provide a place for changing from the horse-drawn to motor vehicle traffic. It is practically impossible to secure livery service in isolated communities at the present time, and in the absence of railroad service it becomes absolutely necessary for motor vehicle traffic to be maintained.

Local merchants in small towns no longer keep



OPEN COUNTRY ALWAYS GIVES TROUBLE FROM DRIFTS

position was the most violent is at the present time an accepted fact and practically uninterrupted service is now demanded, where only a few years ago it was not being attempted and was not even wanted by local residents. This change in attitude is due to the fact that farmers along the routes discovered that by far the best sleighing was over the roads on which snow removal was practised, since enough snow is left on the roads to form a good surface and horses do not have to flounder through drifts always present on the roads on which no snow removal is done. Very few farmers have other than draft horses, and most of the traveling back and forth from town is done by automobile. Even in places where snow removal does not extend to the side roads, it



NO TROUBLE FROM DRIFTS IN THE TIMBER

large stocks of goods on hand, and the closing of the road to motor vehicle traffic, for only a short time, in many sections, may lead to an actual shortage of provisions. This situation occurred in one small Michigan town during the past winter, where, for the first time, they had been extended snow removal service, and due to exceptional circumstances, a three weeks tie-up became quite a serious problem. It is believed that the extension of snow removal service, made necessary by our modern dependence on the motor vehicles, will go on until all of the roads, on at least the state system, will be kept open the year round.

DRIFT PREVENTION

The most important operation connected with winter maintenance is proper drift prevention. In a state such as Michigan, in which alternate stretches

*Engineer of Research and Statistics, Michigan State Highway Department.

of wooded and open territory occur, this idea is very strongly brought out. Adjacent sections in our heavy snow territory show differences in cost of from \$150 to \$300 per mile, depending on the protection afforded by woods. It may be said, as a general rule, that the cost of removal through wooded territory is only from 30 to 50 per cent of that in open country. This indicates that the nearer we can approach this natural protection, the cheaper and more reliable will be our winter road service.

This protection from drifting has, in the past, been largely secured artificially by the use of the portable snow fence. A number of facts recently brought to the attention of engineers engaged in this work have developed the feeling that the unrestricted use of the portable snow fence may not be the most economical solution of the drift prevention problem. Certain limitations in the use of this temporary fence have begun to be quite apparent to some of the users. In the first place, only a small height is economically possible. The four foot woven wire picket fence has proven to be the most popular, because of its low first cost, its portability and the ease with which it can be erected and taken down. It is, in addition, the most effective type of fence, as long as it continues to work, before the snow becomes so deep that it is buried, and results obtained by its use are generally satisfactory for a time. In regions of snowfall where the amount of snow on the ground exceeds from 18 inches to 2 feet on the level, the effectiveness of this fence is obviously decreased by just this amount, and we have for protection along in January or February, not the four feet with which we originally started, but only two or two and one-half feet above the general level, with long, sloping drifts reaching clear to the roadway. The solution is not the use of a higher picket fence, inasmuch as the cost of a 6-foot fence is practically double that of the four foot.

So far, the most common practice has been to raise the shorter fence so that it again becomes effective in stopping drifting snow. This, however, is a more or less expensive procedure. It is hard on the fence, due to the frequent breakage caused by taking out the fence in frozen snow, and the life of the fence is necessarily decreased by this more frequent handling. The experience of Michigan in this regard leads us to believe that this sort of treatment will not give a life of fence of much over five years. As a matter of fact, in a number of places, fence which is only three years old and which has been in territory in which frequent raises were necessary, is in such shape that it is doubtful if it will survive more than one more season.

There is, in addition to the limitations of the fence itself, in some sections, a certain amount of difficulty in securing permission to erect a fence on adjacent property. This is not general by any means, as in most cases the co-operation of the adjoining property owner has been all that could be desired, but it would certainly be far more desirable if the erection of this fence could be made on the right of way of the highway itself, rather than on private property.

The disadvantages of the temporary type of snow fence have led to the serious consideration of its defects, and the installation of a considerable mileage, on an experimental basis, of a permanent type

of snow fence. This snow fence is placed on a right of way which is necessarily wider than would normally be considered necessary. It has been found that, in general, a right of way width of 200 feet will be sufficient to permit this sort of installation, but in certain very heavy snow territory it is possible that these widths must be exceeded. Fortunately for us in Michigan, land values where this sort of treatment is necessary are low, and in many instances the right of way has been secured for the mere replacing of existing fences. In general, right of way in this territory will not exceed fifteen or twenty dollars per acre, which will make the cost of the right of way under \$350 per mile.

The type of fence used is an eight-foot fence, with cedar posts spaced ten feet apart, on which 2x4s are spiked, and on which two four-foot sections of ordinary woven wire picket fence are placed. It is not intended that this fence shall be replaced after it has worn out. At the time the fence is placed, a planting of seedling evergreens is made, in the form of a thick bank with a considerable depth where topographical and cultural conditions would produce snow drifts. It is anticipated that by the time the fence is worn out these evergreens will have attained sufficient size to act as a permanent windbreak, which will keep the road clear of drifting snow.

The exact scheme for planting is more or less experimental at this time. This planting is done irregularly, with greater depths at points at which drifting is most serious, and it is not the intention to produce the effect of a uniform hedge, even where the topography is such that uniform drift conditions occur. It is possible to vary the depth of the planting even here, by making the depth in many places greater than is absolutely necessary to accomplish the desired result. Information on the depth of planting which is necessary is badly needed, as well as is the length of drift formed by various depths and heights of the evergreen banks, in order to give sufficient protection to keep the snow from drifting through. The width of right of way necessary to make this scheme successful is more or less in doubt. It is planned during the coming winter to secure at our experimental snow station, this sort of information. A large number of small evergreen trees will be cut and arranged in varying depths and varying heights, in order to determine what grouping is the most effective, and what length of drift is liable to be formed in heavy snow territory. It is felt that the width of right of way for planting may have to be somewhat greater than would be necessary with the standard type of snow fence.

With the scheme of planting, it is very important that the right-of-way width be wide enough. There is not the danger in getting the snow barrier back too far with a natural windbreak that there is with the ordinary snow fence. The snow fence placed too far from the road permits diagonal winds to carry a considerable amount of snow on to the roadway. Frequent comments are heard that, for some unexplainable reason or other, certain snow fence is not working properly. It will be found on examination, in many cases, that the reason for it is that it has been placed too far back and winds have come from quarters at small angles to the fence, so that the effectiveness of the fence has been very greatly

reduced. With the natural windbreak, this feature is not so essential, as it is always possible to plant the right of way to a greater depth from the fence, and correct this situation.

It is unquestioned that this solution of the problem of drifting snow has much to commend it besides its strictly utilitarian aspect. In many cases, especially in the northern part of Michigan, the roadsides are completely bare of any trees or shrubbery whatever, and it is in these places, especially where the adjoining land is cultivated, that these snow drifts are at their worst. The attractiveness of this sort of roadside treatment is easy to imagine, especially where a few hardwood trees are mixed in with the evergreens, especially maple and birch. The cost of this treatment is not as much as might be imagined. It is estimated that these trees can be planted for about \$20 per thousand, and that from ten to fifteen thousand trees per mile should be ample to produce the results desired.

SNOW REMOVAL

Snow removal itself has settled itself into two very definite operations; first,— the clearing operation done by fast-moving trucks, keeping the center clear; and secondly, heavier, slow-moving units to widen the roadway as the snow accumulates from the center patrol. Both blades and V plows are used for the center patrol, depending on circumstances in many cases, where duplicate equipment is available. The surface left with the blade plow is more satisfactory than that with the V, and in the early part of the season and light snowfall, its use is preferable. In heavier snows, for patrol and considerable widening, the V plow is more suitable. The plow should be so designed that it lifts the snow with a rolling motion, rather than simply shoves it to one side, and should be high enough so that the snow can be lifted over a considerable height of snow bank. The power unit most commonly used for removal of this type is a $3\frac{1}{2}$ -ton six-cylinder truck on pneumatics, although some engineers insist that economical results can be had with the 5-ton outfit. Everyone agrees, however, that trucks should be equipped with six-cylinder motors of better than 75 or 80 H. P. and that pneumatic tires must necessarily be used.

The widening operations should be done by rotary plows, which will spread the snow out instead of piling it up into a high side bank. It costs considerable money to raise snow to any great height, and the lower the banks can be kept, the less difficulty will be experienced from drifting caused by the high side banks and the easier it is to remove accumulations from subsequent storms. The use of displacement plows will increase to a large extent the actual amount necessary to move throughout the winter and they should ordinarily be avoided.

Conditions, however, occasionally arise in which the standard method must be abandoned. For three weeks during last winter very severe storms followed in quick succession in the eastern end of the Upper Peninsula of Michigan. Truck patrol could not keep ahead of the drifting and it finally became so bad that even the tractor rotaries could no longer operate effectively, as the road closed in behind them as fast as it was cleared. To make matters worse, rain fell for two days and the snow on the ground then solidified into a mass of semi-solid ice. The



OPENING ROAD TO DETOUR, MICH., AFTER HEAVY SNOWFALL, MARCH, 1928

rotary plows in this sort of work were completely ineffective, and two of the best known makes were unable to make progress enough to justify their use. Before the roads could be completely cleared, the weather softened and the spring thaw started. The rotaries again, in this slush snow, were very ineffective. In cases of this kind, displacement plows are much more effective in operation where they are properly designed, and it was with this type that the blockade was raised. However, the banks of snow left after this method of clearing were so high that if any subsequent storm had followed before the banks had melted down, in view of the class of material which had been removed, it is doubtful if any plow which we are using could have opened the road again. One of the most successful types of plow used in this clearing was a pull plow modelled on the old woods plow, known in all northern States, and with which it is possible to take out only a few feet at a time in snow cuts. As has been said before, however, this sort of snow removal is not of a kind which would permit efficient and continuous snow removal, although in emergencies it may be necessary to resort to this method in order to get through at all.

Considerable work is necessary on maintenance when the snow begins to melt in the spring, where side banks have attained considerable size throughout the winter. As soon as the thaw commences, ice ruts should be removed promptly, if any have formed in the thaw, and cuts be made through the snow banks in sags in grade, so that melting water can easily run off. Serious washouts have occurred where this drainage has not been effective, and some stretches of road have been entirely blocked by three or four feet of water forming in the road before it breaks through the snow banks and gets away.

Snow removal is one of the hardest kinds of work to which equipment is subjected and constant



ROTARY PLOW ON MICHIGAN ROAD

and careful maintenance of equipment is an absolute necessity for its successful accomplishment. Sufficient spare equipment parts should be on hand so that those parts of the equipment which break the most frequently may be replaced easily and quickly. It is not economical to have a heavy tractor unit tied up for the lack of a few spare parts, when every hour that passes with the road uncleared adds just that much to the difficulty and expense of the final clearing. Too often in this work there are no spare units available when a serious breakdown occurs on one of those units depended on for maintenance of communications. It is highly desirable that one or two spare units be placed in the territory where conditions are severe and blocking is liable to occur very quickly if, for any reason, any one of the units depended on is put out of commission.

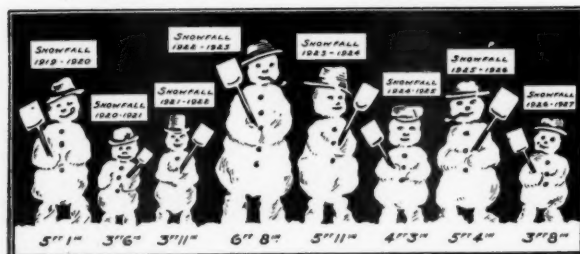
It goes without saying that an efficient and faithful organization is an absolute necessity in successful snow removal. Men must be ready day and night to start out on their work and keep going until the work is done. Relief workers should always be provided where it is possible, as no man can work efficiently for 36 to 48 hours at a stretch. In many cases, however, it is impossible, due to blocked roads between the plow unit working and headquarters, to get relief out to the crews, and it is simply a question of going until they are relieved. The faithfulness and loyalty of crews in this sort of work is remarkable. Long stretches of duty are taken as a matter of course, without complaint and without any particular notion that they are doing anything unusual. It is this sort of an organization which is necessary in dealing with work which many times is more or less of an emergency nature, and one which, in many cases, is vital to the comfort and well being of an isolated community.

Snow Removal in Toronto

Organization a principal factor. Broom sweepers used by street railway. Disposal in sewers, parks and vacant land

The report of George W. Dies, street commissioner of Toronto, Ont., for 1926 contained a great deal of interesting information concerning street cleaning and refuse collection which we embodied in an article in the May 1927 issue of PUBLIC WORKS. Little was said there about snow removal. In his report for 1927 we find interesting information on this subject, from which we have abstracted the following:

SNOWFALL 1919 — 1927



SNOWFALL IN TORONTO, CANADA, 1919 to 1927

"The total snowfall during the winter season 1926-1927 amounted to 45.5 inches. The maximum fall at one time amounted to 5.9 inches, while the mean temperature for the three winter months, January, February and March, was 21.3°, 27° and 35.2°, respectively.

"The commercial and private utility of the motor vehicle to-day demands that street officials place snow removal amongst the essential civic services, and give it considerably more thought than it was given twelve to fifteen years ago, when snow cleaning was confined to a very limited downtown area.

"Organization is a principal factor in the effective and economical removal of snow. The patrolmen are placed in small gangs, under the supervision of a sub-foreman. Additional casual labor is engaged as conditions warrant it.

"Each foreman is responsible for his district. He has his men placed in gangs of twelve to fifteen, stationed at given points and all working in the same direction. First attention is given to the business sections, main car lines, crossings for pedestrians, and car stops. The opening of channels in the vicinity of culverts is performed by small gangs working in defined areas.

"The snow plow is used most advantageously for drifts and windrowing the snow to each side of the roadway, thus permitting the teams and trucks to be loaded as quickly as possible.

"The most effective solution for fighting a snow storm is to work with the storm. In this way the snow does not become packed too firmly to be easily handled and guards against the danger of blocking traffic.

"On carline streets, the Transportation Commission operate snow plows mounted on flat cars, followed by rotary broom sweepers, all of which are equipped with steel blades mounted upon swinging arms which push the snow into a windrow eight to ten feet from the track allowance.

"The congestion and parking of motor vehicles is perhaps the greatest handicap in the performance of the work. While it must be borne in mind that it is also the primary motive for the removal of the snow.

"The disposal is an important item in the economical removal of snow. Long hauls necessarily reduce the loading time, therefore sewer manholes are utilized, where possible, for light snow. The construction of a special snow-hole at Gould and Victoria streets a few years ago has greatly relieved the situation in the down-town area, owing to the greater capacity of the hole and the fact that the disposition of the snow is accelerated by a flow of water from a water main.

"The depositing of snow upon vacant lands, ravines, or park areas is found necessary at times, but has the objectionable feature of an unsightly dump until late in spring, before the last of the snow disappears.

"There are 198.74 miles of street railway (single track mileage). The Transportation Commission pays 30 per cent of the cost of snow removal from all streets having street car and bus lines, and in addition maintains gangs for switches, loops and yards."

In 1927 23,219 loads of snow were removed. The cost, including loading removal, cleaning crossings and gutters, and sanding, but less the Transportation Commission rebate, was \$22,021.88.

Road Construction in 1928

It is reported by the American Road Builders' Association that 45 of the State Highway Departments have reported that they will construct

28,538 miles of good roads during the year 1928, Connecticut, Virginia and West Virginia not having reported up to this time as to their official programs. With the work of these three states added, the total should approximate 30,000 miles.

Expenditures contemplated by 46 of the states total \$1,307,821,000, which is about \$184,000,000 more than was expended by all the states in 1927.

Snow Handling in Onondaga County

County has standardized on V-shaped plows, mounted on powerful, rapid trucks as far as possible. Snow fences used. Snow fighting force housed at headquarters all winter

By R. B. Traver*

Beginning two winters ago with less than a hundred miles in its snow removal system, Onondaga County, New York, kept 310 miles cleared of snow during the winter 1927-28. The total mileage of improved roads in the county is approximately 600 and it is probable that within the next two years the remaining 290 miles will be added to the snow removal program.

During the session of the New York Legislature in 1926 the highway law was changed permitting the Board of Supervisors of any county to appropriate annually and expend such funds as it deemed proper for the removal of snow from the highways of the county; the Board of Supervisors to designate the highways from which the snow is to be removed and the work to be conducted under the direction of the county superintendent, in a manner to be determined by the board.

In the fall of that year the Board of Supervisors of Onondaga County took advantage of this act of the Legislature and made an appropriation for the removal of snow from the main arteries leading into the city of Syracuse and directed the purchase of equipment for the work. Later on in the season, additional roads were added and more money appropriated. The snow removal work was carried on throughout the season and met with quite general approval; and the appropriation and mileage were increased greatly the following winter.

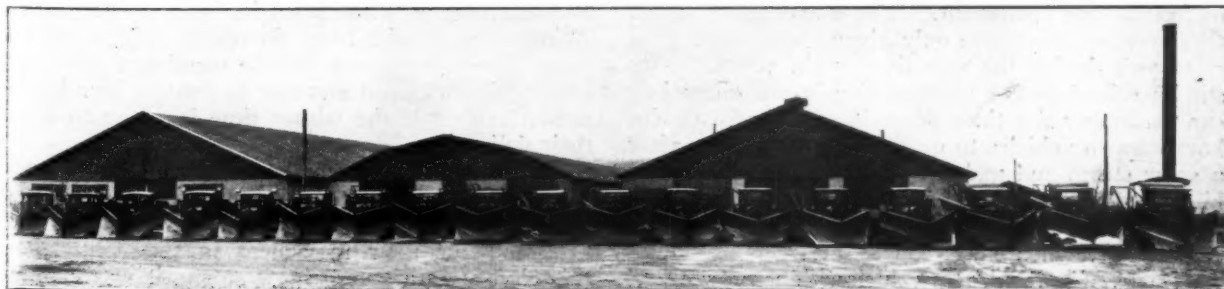
The State of New York makes no provision for aiding the counties in keeping the highways clear, but as some counties think it advisable to open the

state highways (which are generally even more important than the county highways), it seems as though some assistance should be received from the state. An unsuccessful effort was made to obtain the passage of a bill through the 1927 Legislature by which state aid would be granted to the several counties, so a complete program could be carried out covering all the main arteries of the state. As it is now, some of the through state highways may be cleared in one county but the next county may not see fit to do so, and this interferes with the use of these highways for through traffic.

With the experience by the Onondaga County Department, and with the growing approval of the citizens for this snow removal work, the mileage included in the removal program has been increased until, as stated, last winter 310 miles were kept clear.

Most of the trouble from drifting snow is found in the southern end of the county, which is mountainous and where severe winds are more frequent than in the northern part. Prevention of drifting by the use of snow fences is practiced to a certain extent, 40,000 feet of snow fence having been set last winter by the county and additional fences by certain of the towns. The slat type of fence is used, competitive bids being received for same. The cost of installing and removing the 40,000 feet of snow fence last winter was \$1,824. Permanent snow fences or snow hedges are not considered, as they would be worse than useless unless set well outside the right of way, and the farmers object to this because of the land it would render nearly useless for cultivation.

*County Superintendent, Onondaga County Dept. of Highways.



GARAGE (AT LEFT), STORE-HOUSE (CENTER) AND REPAIR SHOP (RIGHT) AT JAMESTOWN, WITH SNOW PLOWS MOUNTED ON TRUCKS READY FOR SERVICE



CLEARED ROAD IN ONONDAGA COUNTY AFTER AN ORDINARY STORM

The county uses V-shaped plow almost entirely, having standardized on the Frink plow; although it has two rotary plows which it uses to a certain extent. Twenty-five Frink plows are kept at the shops at Janesville, which is the headquarters from which snow removal campaigns start in all directions, this being near the center of the county. For pushing the plows, the county uses trucks and other apparatus employed in the summer work of county road construction and maintenance. The thirteen Walter trucks owned by the county are used for this purpose and are preferred for snow removal work because, with powerful engine and four-wheel drive, they are able to travel 30 to 35 miles an hour while pushing snow.

At the headquarters at Jamesville are a large garage, store house and repair shop, and there are quarters here for 40 men or more. Thirty-five to forty are housed there continuously during the winter, ready for instant service in snow fighting. Thus no time is lost sending out for men to man the plows, but on fifteen minutes' notice the entire twenty-five outfits can be on the road ready for work.

Snow removal work is in charge of F. J. Lees, superintendent of construction. In addition, the county carries over from its summer work the foremen and also other reliable men of good judgment. Each plow, when it starts out, has, in addition to the driver, one of these reliable men in charge. While

it is possible that one man could handle the plow, it is believed that the addition of a foreman in charge is justified by the results obtained.

The instructions for the crews are to open the roads and keep them open as long as the snow is falling or blowing, and this may necessitate their being out two or three days at a stretch. During this time they sleep and obtain hot meals at hotels or farmhouses, which can be found at short intervals throughout all the main roads of the county.

The practice is to remove snow not only over the paved section of the roads but off of a large part if not the whole of the shoulders as well.

The plows are provided with wings, and when the drifts are quite deep, say over 5 feet, the plows without the wings are first used for pushing back the snow, then the road is again gone over with the wings out and in this way drifts as high as the top of the cab can be moved back from the road.

A trouble truck is maintained, not only to send out for repairing plows or other county equipment, but also for taking out gasoline when the trucks telephone in for it.

The plows are sent out when the snow has reached a depth of about five inches, and the snow is maintained at a depth of three to five inches throughout the winter. This prevents the formation of ruts, which are so fatal to any kind of highway pavement.

In keeping the accounts of the highway department, the rental system is used for equipment; that is, each piece of equipment is charged against the work on which it is used at a certain per diem rate, the labor also is charged against the job, and the overhead is apportioned. During the winter 1927-28 the rental of equipment totaled \$5,326; labor (foremen and drivers), \$7,367, while the overhead totaled \$506 for expenses and \$3,159 for supplies.

The first winter the average cost of keeping the roads cleaned of the snow was about \$65 a mile. Last year, with a larger mileage and with more experience in the selection and use of equipment, the rate was cut down to about \$53 a mile, not including the snow fences, or a little less than \$59 per mile including the fences.

Fighting Snow in Albany

By Lester W. Herzog*

The extensions of snow removal operations and the improvement of methods have been so rapid as to be one of the outstanding features of municipal work. This has been caused by the rapid increase of automotive equipment. It is a matter of record that average cities have only given their attention to this work during the past five or six years. Boys still in school in the average city in the snow belt can remember the time when it was necessary for horse drawn vehicles to go through the streets after a snow storm and make a track before an automobile could run. Automobiles, when run at all during the winter, followed the car tracks, which were cleaned, or, when going on side streets, followed the tracks of horse-drawn vehicles. The only streets

cleared were a few of the business streets over which the trolleys ran. In Albany the trolley companies cleared the snow from their tracks and the city, in conjunction with the trolley companies, removed the accumulation of snow from in front of the stores. This was done with hand shovelers, sleighs and flat cars. It was necessary for the merchants who used automobile trucks in summer to own or hire horse-drawn vehicle in the winter time in order to make their deliveries.

Cities themselves were backward in this respect. Many of them motorized their fire departments either completely or in part without making any provision for their movement in the winter. In this city, after a severe snow storm, it was customary to keep horse-drawn engines in the fire houses during the winter.

*Commissioner of Public Works, Albany, N. Y.

There was really very little demand for snow removal from the public at that time and practically none from the newspapers. As a matter of fact, the city officials themselves took the first step to relieve this condition and snow removal naturally became very popular at once.

It was, of course, impossible for them to purchase the entire necessary equipment at one time. The public had to be educated to a point where they would approve of expenditure of funds for this purpose. I can recall Albany's first extensive snow removal campaign, which happened during the first of my administration in 1924, when one of the merchants wrote a letter of criticism to the department because we had plowed the streets so clean that his horse-drawn sleighs had difficulty in covering their routes.

It must be understood that, in speaking of cities in a general sense in this article, I am taking cities of the average size of Albany, which is a second class city with a population of approximately 135,000.

Albany was, I understand, one of the first if not the first second-class city in the east to purchase modern snow removal equipment and has been known throughout the country as one of the first cities of its size to adequately handle the snow problem. Our first first snow loader, a Barber-Green, was purchased in 1922 or 1923. This was used on the business streets which formerly had been cleared by hand labor. No appropriations were made at that time for the removal of snow. The following year we experimented with various types of equipment and in this connection I might say we are still experimenting. We never purchase any snow removal equipment which is unknown to us without having an adequate test demonstration given, the results of which must be satisfactory to the Public Works Department. At first we adopted a Caterpillar type of tractor and purchased two of them—one ten-ton and one five-ton. We found that, while it was an absolute necessity to have this heavy type of equipment (which was also used throughout the summer) we needed something also which could move more rapidly. We increased our heavy duty equipment by another five-ton tractor and in addition we purchased 15 trucks plows which were placed on the front of our own trucks. Later on we decided it was more economical to hire heavier trucks for these plows, as we found they worked better with five-ton trucks.

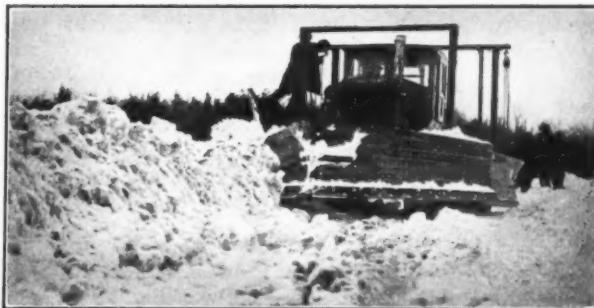
We then found that our snow removal costs with one snow loader were rather heavy, due to the fact that it was necessary to hire a great many more trucks than the snow loader could actually handle. This was due to trucks being delayed at the dumps and through traffic. We then purchased a second Barber Green snow loader which is used in conjunction with the first.



LOADING SNOW AT NIGHT IN THE BUSINESS SECTION

One loader is used on each side of the street and we demonstrated we could operate the two snow loaders with the minimum of trucks required for the one.

In our first experiment, we used all types of trucks, many without dumping facilities as it was impossible to hire sufficient dump trucks. The condition now is just the reverse, for we can secure a great many more dumping trucks than we can possibly use. In Albany, we do our main dumping in the river and we formerly needed a force of from 20 to 40 men at the various docks; but we now place on each dock one of our tractors with a bulldozer attachment and this handles all the snow that can possibly be brought to it.



Illustrations courtesy Albany Evening News

TWO TYPES OF PLOW USED BY ALBANY

We rapidly extended our actual snow removal from the main business streets to some of the smaller business streets, and then to some of the residential streets which are main arteries of traffic. In addition to this, we move the snow oftener; particularly in the beginning of the winter. Snow which, falling in March, would be left for the sun to melt, when falling earlier in the winter is removed at once in order that it will not freeze and make a bad bottom.

We then extended this service to include all the churches, and now remove snow from in front of these institutions. At one of the meetings of the International Association of Street Sanitation Officials, a suggestion was made in regard to removing snow where funerals are to take place. We immediately adopted this idea and it has been in practice during the past three years. The newspapers are watched and wherever a death has occurred, the city's forces immediately remove the snow from in front of the house where the funeral is to be. This has met with universal approval—in fact, each year the Association of Undertakers has passed a resolution thanking the city for this service.

Our general procedure when it starts to snow is to watch conditions very carefully and I might say that it is the one particular job of the city that the commissioner's office gives personal attention to. We get various weather reports, and if from these and our own experience we consider the storm will continue, we immediately get our equipment ready and start them out. From the time the first plow leaves the department's garage, there is continuous service until the job is completed. The snow loaders worked formerly only at night. We now send them out as soon as the side walks are cleared. In the business section, we have a one-hour parking law and our men string red lanterns along the streets which are to be cleared. The police give us their cooperation in keeping autos off the streets at that time and we are now able to clean our business streets during the day time.

The trolley companies are required under the law to clear and remove the snow from their tracks. We have an arrangement with the company whereby the total mileage is considered and instead of clearing the amount they have thrown over, they take certain streets in certain sections and remove all the snow, and the city takes other streets where car tracks are located and removes the entire amount of snow from them.

The city administration of Albany has been very liberal with appropriations for this class of work although, like every other city, it is impossible to secure appropriations during the summer. Every-one figures, in the summer time, there will be no snow the next winter. We have an appropriation in the budget this year of \$40,000 for snow removal, although this is only the third year that a special appropriation has been made for this purpose.

During the past five years, our equipment has increased from nothing to approximately \$100,000 to \$150,000 worth, which is used either entirely or particularly for snow removal purposes.

We have at the present time 1 10-ton Best tractor, 1 5-ton Best tractor, 1 5-ton Monarch tractor for heavy duty, 2 Walter Snow Fighters for rapid,

heavy duty, 15 to 20 truck plows, 2 Barber-Green snow loaders, 3 Fordsons with plowing equipment, 1 Wehr Grader, which is usually used for snow plowing, besides a great quantity of smaller equipment.

For bad ice conditions, we use an air compressor equipped with light, wide spades which we have found the best for this purpose. We are always on the lookout for more modern equipment and are always willing to try anything that is offered that will improve the service.

A new condition which has arisen with the advent of the air plane is the handling of snow at the various air ports. As far as we can find, there is nothing as yet which is really satisfactory and at the next meeting of the International Association of Street Sanitation Officials to be held at Toronto October 8th and 9th, I understand that this subject is to be thoroughly discussed.

Sometimes we run up against a condition which we are absolutely unable to handle and that is of wet snow followed by a freeze. This happened about three years ago when we had a heavy, wet snow which our smaller equipment was unable to move. A sudden fall in temperature came and this wet snow froze solid, causing ruts wherever an automobile had passed through. This happened in February and we had no further thaws that winter until early in April and it caused a wretched condition of the streets, which was blamed on the Street Department, when it was a condition absolutely beyond their control. A peculiar thing about it was that the city of Albany was the only one that had this condition. The snow storm was local and did not affect cities only ten or fifteen miles away.

It is impossible for a city of this size to move all snow. I have figured that if the city of Albany removed all its snow from its streets, it would cost more than the total budget appropriated for all purposes, and in addition, it would be physically impossible to do it; we have not enough dump facilities except when the river is open, and usually the river is frozen over from December on, and it would be impossible to hire sufficient men or even sufficient trucks. Neither do I consider it necessary; all the public desires is that the streets be made fit for automobile traffic.

The financial value of opening streets must be enormous. When practically every owner of an automobile is able to run his car during the winter, the value of sales of automobile equipment can hardly be estimated. The return to the merchants due to the fact that people can get to their stores conveniently is another great factor of economic value and the cost is a very small percentage of the actual return.

Fighting snow is an interesting proposition. It is a great satisfaction when a blizzard occurs to have all the main streets of a city opened by early morning, and this is always done. Of course, when a blizzard happens early in the morning, it is impossible to have the streets open in time for the morning traffic but we have enough open so the public can get to their places of work.

The street departments of cities cannot be given enough commendation for the work they do. I have known men on our equipment who worked

nearly 48 hours without relief in temperatures below zero and working in the open with high winds blowing. In big blizzards, my deputies and I have often worked steadily for two, three and four days with not more than from thirty minutes to an hour's sleep at a time.

Snow removal, while a serious business, has also its amusing side. This year very little snow fell in the city of Albany and a small proportion of our snow removal fund was used. We had numerous inquiries, particularly from the newspapers, as to what we were doing with this money. It finally became a standing joke—some believed that this money was kept in a bag in the commissioner's office.

We sometimes get very foolish requests for the removal of snow for various purposes. I recall one instance when a lady telephoned my office and complained that the snow plow had come through and covered up a path shovelled out in front of her house. The explanation that the snow removal equipment was on that street at the time and would be in front of her house within an hour which would remove all the snow apparently did not satisfy her, although it had been the first time the snow had actually been removed on that street.

Demands are sometimes made for snow removal which are absolutely unnecessary. The street departments, which usually have control over snow removal, are perhaps the best judges of when snow should be plowed or removed. Our experience has shown that many times when there has been a light snow storm, if the streets are plowed they are made worse than if the snow had been left on the street, because the snow, being piled in the gutters, does not melt as rapidly as it would if left on the street.

There is a great deal of buncombe about snow removal all over the country. Newspapers which are opposed to the political organization which happens to be in power in their city make all kinds of unfair criticisms on snow removal operations and publish pictures which are not applicable to general conditions.

Second Pan-American Road Congress

The program and regulations for the Second Pan-American Road Congress to be held June 19 to July 3, inclusive, of next year, in Rio de Janeiro, have just been approved by the Minister of Transportation.

The program calls for discussion of a variety of subjects: methods of construction and conservation of roads, circulation, exploration, legislation, administration, finances and economics, international and Pan-American agreements, propaganda, education, and other themes.

The regulations of the Congress, which have for their object the choosing of methods and systems and the co-ordination of forces concerned with the construction, exploration, conservation, and financing of roads, provide that the congress shall be constituted of the representatives of the republics of the Pan American Union and of those private associations and companies which have obtained admission. The former—that is,

the official members—will have voice and vote in all sessions and will be invited by the Brazilian Government to take part in all acts, excursions and festivities of the congress. The adhering (unofficial) members can take part in the sessions, with the right to speak, but without the privilege of voting. All will present their credentials to the committee on organization of the congress (Commissao organizadora) before the date of the preliminary session, all requests for inscription by adhering (unofficial) members being required before March 1, 1929.

The official members will meet on June 19, 1929, to elect the president and executive committee of the congress.

The congress will hold two plenary sessions, one at the opening and the other at the close, besides other ordinary sessions to deliberate on the proposals presented.

Except in the case of a special resolution of the assembly, no speaker will be permitted, while discussing the same subject, to have the floor more than twice, and each time he will be allowed ten minutes. All papers presented must be in Portuguese, Spanish, English, or French, with 10,000 words as a maximum for any paper, and all papers must be accompanied by a resumé not exceeding 1,500 words, written in the language of the original paper, with a translation of the resumé into Portuguese.

All papers must be presented in triplicate to the committee on organization (Commissao organizadora) before March 1, 1929, in order that the committee will have time to decide whether the respective papers may be presented at the sessions of the congress.

Improving Poor Subgrade

In his annual report for 1927 as city engineer of Salt Lake City, Harry C. Jessen describes as follows the method employed for improving poor subgrade on which concrete pavement was to be laid.

"Due to unsuitable subgrade conditions, gravel fill was specified as a subbase. This was paced in the following manner: Excavation was carried to approximate subgrade, after which the entire surface was thoroughly rolled with a 12-ton road roller, which depressed the surface 1 inch to 1½ inches. Gravel was then spread to a depth of about 1½ inches and mixed with the subgrade material by means of a spring tooth harrow. A thorough sprinkling with water followed by more rolling completed the process in most cases. Thus a smooth unyielding crust was formed for the deposition of the concrete which was disturbed but very little by the heavily loaded trucks hauling the concrete aggregate.

"Owing to exceptionally poor subgrade conditions for a distance of about 500 feet each way from Fayette Avenue, the excavation was carried one foot below subgrade and refilled with the material excavated from the top layer of the street. This was material which had been hauled in for road building purposes and made an excellent foundation. As an added precaution steel reinforcement was used in this portion of the pavement."

Service Pipe in Washington Suburban Sanitary District*

Steel and 1¼-inch cast iron formerly used but now standardizing on soft copper. Used in same trench with sewer connections. Laid under pavement by means of earth augur

The Washington Suburban Sanitary District, a suburban section in Maryland adjacent to the District of Columbia, has a population of about 60,000 which was served by about 50 miles of water mains and 1,500 service pipes in 1918, when the district was organized, and now contains roughly 250 miles of mains and nearly 11,000 water connections. New services are being connected at the rate of from 1,200 to 2,000 annually. The water supply comes from a stream without an impounding reservoir, treated by ordinary rapid sand filtration and chlorination. It is reasonably soft, having a hardness ranging from 10 to 30 parts per million. Red water troubles in connection with galvanized service pipes are prevented by the use of lime after filtration.

Soil conditions differ widely. In many sections, rock of various degrees of hardness is encountered; in others there is stiff clay or mixtures of clay with loam or sand; and in still others sand, gravel and sand, or river silt occur.

Up to 1918 practically all of the services were of galvanized steel, although a few were lead. During the ten years of the district's existence, necessity has arisen for renewing many of the old steel connections, both on account of complaint of insufficient flow and because of grading and paving operations. These services have been in use from perhaps 8 to 25 years. The pipe, with few exceptions, contained much clogging material and many of them had waterways so small as to be scarcely discernible. Outside surfaces also frequently have shown pitting and some of the pipe was so far gone that it has been impossible to thread the ends left in the ground on private premises.

Galvanized genuine wrought iron house connections were laid exclusively during the first few years of the district's existence and none of these as yet has been taken out on account of deterioration. Those that have been replaced for other reasons have shown the pipe to be in practically as good condition as when laid. Mr. Morse, however, believes that if the same water had continued in use as was formerly served to some of the original systems, the result might have been different, for the galvanized steel services in some of the old systems have been found in a much better state of preservation than those of about the same age in others.

There has been some trouble with uneven wall thickness in the 1¼ inch cast iron pipe used for services, but this has not been serious. The greatest objection to cast iron services of 1¼ inch diameter has arisen from breakage due to rapid settlement of freshly backfilled trenches, but even this has not been serious enough to cause much concern. This diffi-

culty is due mostly to the practice of installing water and sewer connections in the same trench, the same organization of the district having charge of both systems. The cast iron service pipes were laid on a narrow bench in the side of the sewer connection trenches and it was the practice to brace this pipe by means of transverse wooden struts. While some of these wooden struts would get dislodged, with consequent breaking of the service pipe, when extremely heavy rains settled the backfill too rapidly, the increased maintenance expense caused by the comparatively few failures was much more than over-balanced by the large saving arising from the installation of the water and sewer pipe in the same trench. Much of this trouble was avoided later on by using wrought iron pipe where soil conditions were decidedly unstable.

After a thorough consideration of the probable serviceability of copper tubing for water connections and the prospect that this material, with the elimination of some of the fittings previously used, would cost at least no more for installation than 1¼ inch cast iron pipe, he decided somewhat more than a year ago to standardize on it for all services where ¾ and 1 inch pipe could be used.

The first copper tubing purchased was too hard to allow sharp bending without the appearance of cracks. As the mains were tapped on an angle of about 45 degrees it was necessary to connect the tubing to the corporation cock by means of a brass ⅛ bend and a brass-to-copper fitting. It was not possible to turn the tubing up vertically so as to form a riser in the meter housing, and a malleable iron ell was used, connected with the copper tubing by means of a copper-to-iron fitting in the bottom of the housing.

The brass ⅛ bend at the corporation cock eliminated the use of a lead gooseneck but proved to be a more expensive arrangement than a copper gooseneck. The necessity of installing a brass bend at the corporation cock and an iron elbow and copper-to-iron fitting at the meter housing was soon avoided through the use of soft copper tubing. All tubing except that first purchased has been of this grade. Not only has the soft tubing eliminated the need of a lead gooseneck or brass bend at the main and fittings at the meter housing, but it has provided a service of such flexibility that any desired deflection in line can be made without difficulty.

The present practice is to bend the end of the copper tubing to the form of a gooseneck and connect it with the corporation cock by a copper-to-brass coupling, then join together with copper-to-copper fittings such tube lengths as may be necessary to reach the meter housings. At the housings the copper tubing is bent to a 90 degree arc with a radius of

*From a paper read before the annual convention of the American Water Works Association, by Robert T. Morse, chief engineer, Washington Suburban Sanitary District.

about 6 inches and is extended vertically in the housing up to the inlet end of the meter.

In bending the tubing, use is made of a grooved wheel having a diameter of 6 inches. The tubing is held under a fixed peg and the part at which the bend is to be made is placed in the groove. By the application of pressure and the gradual slipping of the tube backward and forward, the desired degree of curvature is obtained. Also it is possible to bend the tubing by inserting it in a piece of iron pipe and gradually applying pressure on the latter. No perceptible distortion of section results from the bending process.

When using copper services in the same trench with sewer connections, no bench is required but it is necessary only to tamp the backfill to the required height over the sewer pipe and to wedge a few wooden sills across the trench as support for the tubing. A great many of the copper service pipes in the district have been laid in this manner and in only one case has trouble occurred, when the sewer connection ditch was about 14 feet deep and the backfill very soft.

Where water connections must be placed under improved pavements, an earth augur is used having a diameter of two inches and made up in sections two feet long. The copper tubing is passed without difficulty through the hole made by the augur.

Mr. Morse gave the prices for tubing and other kinds of service pipe delivered in the district. Three-quarter-inch pipe costs 35c per lineal foot for AA lead, 14.15c for copper tubing, 10.17c for galvanized wrought iron and 6.40c for galvanized steel. Two-inch pipe cost 90c per lineal foot for AA lead, 44.25c for copper tubing, 33.31c for galvanized wrought iron, 22c for cast iron and 19.82c for galvanized steel. Similar ratios are found between the prices for 1-inch, 1¼-inch and 1½-inch pipe. One and one-quarter-inch cast iron, the smallest size used, costs 18.33c, which is more than ¾ inch or 1 inch copper tubing, but less than 1¼ inch. Lead pipe costs from two to three times as much as copper tubing, is more expensive to transport and install, and has physical disadvantages, so that the writer can see no reason for using it except under very special conditions. There have been no complaints of discoloration of fixtures due to the action of water on copper tubing.

Charleston Water Works Notes

In his annual report for the year 1927, J. E. Gibson, manager and engineer of the Water Department of Charleston, S. C., gives the following information concerning the city's water purification plant:

"The treatment of the water has been the same as heretofore and consists of sterilization of the raw water with liquid chlorine; coagulation with sulphate of alumina; sedimentation and filtration through gravity mechanical filters; and restoration of alkalinity after filtration with sodium hydroxide.

"During the algae growing season copper sulphate is used in the impounding reservoir with small amounts at the outlet from the sedimentation basin to the filters and a much restricted amount used in the clear water basin to prevent the growth of algae in this basin.

"On February 10, 1927, the aeration system in the sedimentation basin was put into operation and this marked a most definite change in the treatment of our water before sedimentation. Heretofore, due to the reaction of the sulphate of alumina and chlorine in the raw water, we have had great difficulty, especially during the algae growing season, from the increase in carbonic acid gas and the pronounced odors and tastes in the raw water. With the installation of the aeration system we were able during the entire season of 1927 to maintain the carbonic acid content of the settled water as low or lower than in the storage basin before treatment and a marked reduction in the odor and taste of the settled water leaving the sedimentation basin and returning on to the filters.

"Caustic soda or sodium hydroxide is used to restore the alkalinity in the filtered water after filtration. Our years of experience have conclusively demonstrated the advantage of caustic soda over lime as formerly used.

"The hydrogen-ion concentration (pH value) of the filtered water delivered to the mains averaged 8.1 throughout the year. While this is higher than usually considered necessary, we find it to be on the side of safety and it has almost entirely eliminated the complaints of "red water" in the hot water supply."

Water Softening at Hinsdale*

Modern equipment, including mechanical agitation, dry feed, clarifier for continuous sludge removal and carbon dioxide machine. Sodium aluminate used

By H. Menold†

The new water softening plant of the municipal water work of Hinsdale, Ill., costing in excess of \$100,000, was put under construction in August, 1924, and operation was started in September 1925. The plant was designed for a maximum of 3,000,000 gal. per day. It has all the modern equipment, utilizing mechanical agitation in the mixing tanks, dry feed machines for chemicals, a clarifier for continuous removal of sludge, a pump for the repumping of sludge, and a carbon dioxide machine. The plant is constructed on a unit plan so that the present unit can be expanded when necessary.

The raw water, carrying a hardness of about 468 and an alkalinity of 375, is pumped from a deep well equipped with a deep-well centrifugal pump. The raw water is divided between two mixing tanks, entering at the bottom. Hydrated lime and soda ash are fed into the mixing tanks by automatic proportioning dry feed machines. Alum was formerly added at this point and in the same manner. The repumped sludge also is added and the whole is mechanically agitated. The treated water passes from the mixing tanks to a long trough where 34 per cent liquid sodium aluminate is added, proportioned by a small motor-driven pump. The water passes next to the clarifying basin, where a majority

* Paper before Illinois Section, Am. Water Works Ass'n.
† Superintendent of Utilities, Hinsdale, Ill.

of the solids are precipitated, and then it goes to the settling basin. From the settling basin the treated water passes over a weir to the carbonating basin where the carbon dioxide is added. After carbonization comes the filters and storage.

The Hinsdale raw water in September, 1926, had a hardness of 468 and an alkalinity of 375, in parts per million. At that time this was the hardest water that was being softened by any municipality, and furthermore, this water is very difficult to soften because of the high magnesium content. The consulting chemist recommended a finished water having a total hardness of 85, total alkalinity of 85 and twice the phenol alkalinity of 85. Considerable difficulty was encountered when an attempt was made to reach and maintain an 85 part water. Lime, soda ash and alum would not react and give this quality of treated water without imparting considerable excess caustic alkalinity. Excessive caustic alkalinity in turn, increased the work of the carbonator. To reduce the overloaded carbonator and the excessive caustic alkalinity while securing water of standard 85 parts, it was decided to try the then new alkaline coagulant and softening chemical, sodium aluminate.

Sodium aluminate being alkaline, it is not necessary to increase the lime and soda ash, as is necessary with the acid coagulant alum. As a matter of fact, sodium aluminate permits a reduction in the soda ash charge. In addition, faster reaction and better coagulation is obtained with sodium aluminate and a softer water can be delivered from the plant.

Prior to the use of sodium aluminate, the water was treated with 3.15 lb. of hydrated lime, 0.933 lb. of soda ash, and $\frac{1}{8}$ lb. of alum per 1,000 gal., resulting in a water from the Dorr clarifier showing a total hardness of 133, alkalinity 147, with 23 p. p. m. of caustic alkalinity. This water was then treated with 3.3 lb. of hydrated lime, $\frac{3}{4}$ lb. of soda ash and 0.28 lb. of liquid sodium aluminate, resulting in a water with 87 p. p. m. total hardness, 85 alkalinity, and only 15 of caustic alkalinity. Thus, by substituting $\frac{1}{4}$ lb. of the liquid sodium aluminate for $\frac{1}{8}$ lb. of alum and increasing the lime 5 per cent and decreasing the soda ash 18 per cent, a water was obtained with almost 45 per cent reduction in total hardness. Note that this remarkably lower hardness was accomplished with 8 parts lower hydrate excess even though the potential hydrates from the lime and sodium aluminate were increased. This treatment resulted in a reduction in cost of chemicals of 4.1 per cent, a marked reduction in the total amount of water used for backwashing of filters, and a reduction of 21 per cent in the total amount of gas used for recarbonization.

These comparisons were made on operation with alum during the early part of September, 1926, and with sodium aluminate during the latter part of November of the same year. Comparison of the results obtained with alum during September, 1926, with those obtained in September, 1927, using sodium aluminate showed greater improvement. The total amount of water used for filter backwashing had been reduced 64 per cent and the gas consumption had been reduced 36 per cent. In 1926, when alum was used, the percentage of backwash was 2.6. During September, 1927, the percentage was 0.94. This remarkable decrease in the amount of water

used for backwashing was due to the improved coagulation obtained by the use of sodium aluminate, which improved the settling in the Dorr clarifier. During the use of alum, a scale of considerable thickness formed on the walls of the filters and basins. Continued use of sodium aluminate has removed practically all of this scale.

It has been our observation, particularly with a high magnesium raw water, that a high grade of hydrated lime must be used. A good grade of soda ash should always be used; however, a slight variation in the soda ash quality does not so materially affect the results. All chemicals should be bought on specifications which will insure a uniform quality.

We are now planning to start a test of the 84 per cent solid sodium aluminate which will be proportioned and fed by a new type of feeder recently perfected. We hope to duplicate the results obtained by the use of the liquid material.

I hear few complaints from the users of our water, so I have concluded that for household and drinking purposes we are supplying a finished product that is generally satisfactory.

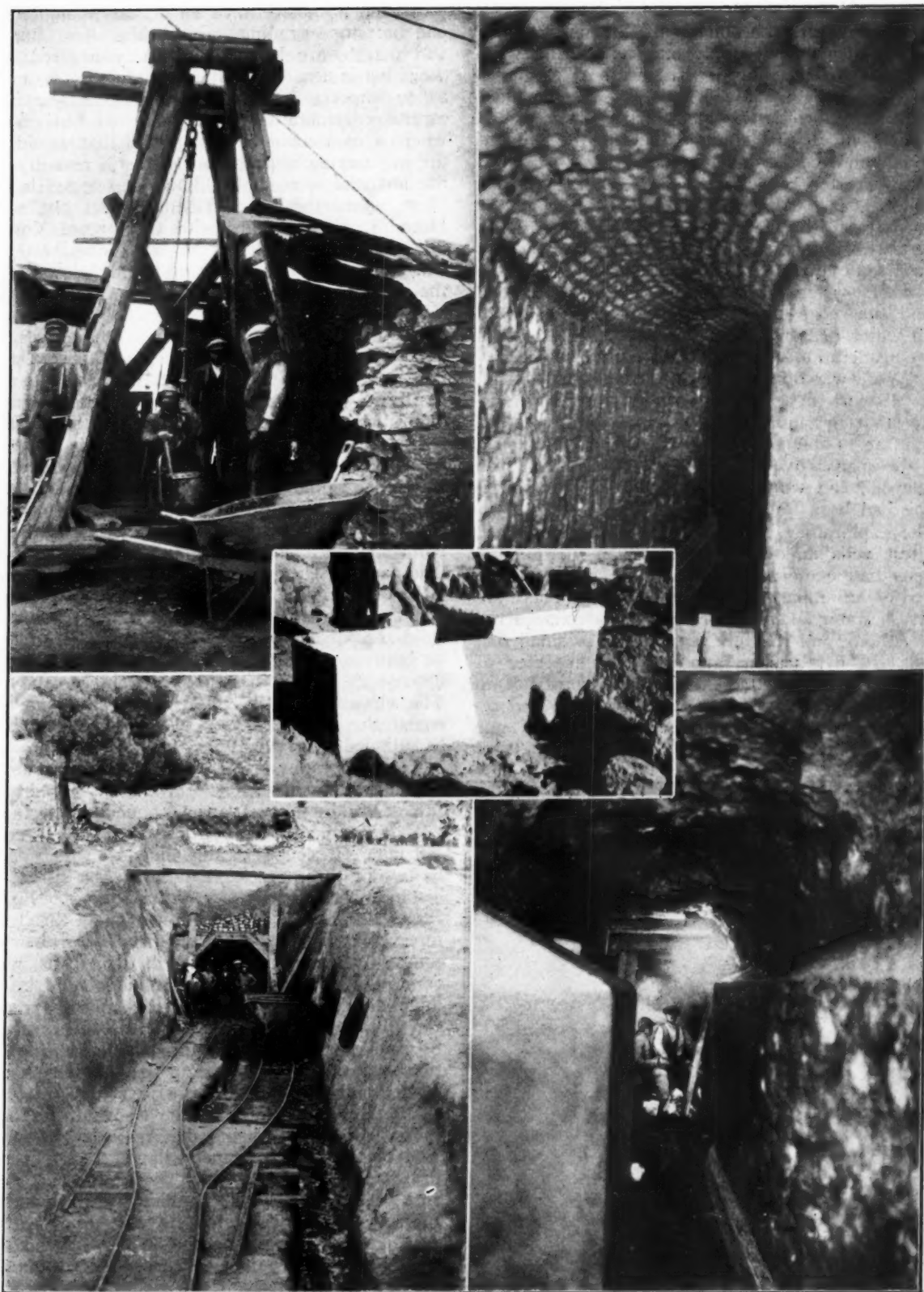
New Water Supply for Athens, Greece

Utilizes tunnel aqueduct eighteen hundred years old. New 8.3-mile tunnel to new reservoir making record progress with modern equipment and native labor

The Roman Emperor Hadrian undertook a project for building a modern city close to Athens, called Hadrianapolis, and to supply this with water, constructed an underground aqueduct about 14 miles long, which was completed in 140 A. D. The water brought by this aqueduct was stored in a tower near the city and distributed by gravity.

Up until the time the barbarians overran Greece, the Hadrian aqueduct served as the principal source of water supply. Little is known of what transpired during the time the barbarians held sway over eastern Europe, excepting that it was an age of destruction and degeneracy, devoid of recorded history. It was probably during this period that the Hadrian aqueduct was effectively lost, but fortunately not destroyed.

Less than a century ago modern Athens was founded. It was built around ancient Athens and purely by accident the old Hadrian aqueduct was discovered, repaired and put back in service. Today it is again the principal source of water supply to Athens, but woefully inadequate. The growth of Athens during the last ten years has been explosive—the exchange of nationals between the Greeks and Turks by treaty agreement following the last war between these two countries literally flooded the city with returning refugees. From a city of less than a quarter of a million souls it jumped almost overnight to three-quarters of a million inhabitants. Prior to this the Hadrian aqueduct was just about able to supply the city, but under the new conditions



VIEWS OF WORK ON ATHENS WATER SUPPLY

Upper left—Handling spoil from the Ancient Hadrian aqueduct. Upper right and lower left—Relining the Hadrian aqueduct. Center—A stone sarcophagus beside the rock cap to an old shaft of the Hadrian aqueduct. Lower left—South portal of the new Boylati tunnel.

the supply furnishes less than four gallons per day per capita during the dry season.

For many years the officials of Athens had been searching for a new supply and considering ways and means of developing it. Engineers of many nationalities had studied the problem, recommendations and reports were filed, prizes offered and awarded, but all this did not alleviate the ever-increasing thirst of the inhabitants.

Finally, after every avenue of relief had been considered, a contract was entered into during the early part of 1925 between Ulen and Company of New York City and the Greek Government, whereby the company agreed to finance, design and build the new water system; also repair the existing system, extend and repair the Hadrian aqueduct and install a salt water (Aegean Sea) street sprinkling system. The consideration was \$11,000,000 in Greek securities. Work was immediately begun and on July 1st, 1926 all work in connection with the existing system, Hadrian aqueduct and salt water system, amounting to about \$1,000,000, had been completed, and the plans covering the new supply had been developed; and work on this phase of the undertaking had been initiated.

The exploratory work of the Hadrian aqueduct, and test wells sunk all over the region surrounding Athens had demonstrated that little could be expected of an ample underground supply. There are no fresh water lakes or springs of any consequence near Athens, and the few streams are so small that during the dry season little could be expected of them. The only solution left was to construct an impounding reservoir which would capture and retain the runoff of the tributary territory of one of these streams.



MAP OF COUNTRY AROUND ATHENS, SHOWING MARATHON RESERVOIR AND AQUEDUCT

The country around Athens is rough and the formation is mostly mica schist, clay, conglomerate and limestone grading into marble. The limestone and marble are broken and badly fissured, while the schist is dense and offers satisfactory assurances as to impermeability. After diligent search and careful consideration there remained but one site where a dam could be constructed that would meet the engineering requirements and still remain within the financial limitations. The site selected is about 15 miles northeast of Athens, where the stream Haradra, after uniting with the stream Varnavo, flows through a gorge, the walls and bottom of which are mica schist. Above and below the site the limestone and marble outcrop, but the mica schist fold, if such it may be called, can be traced for miles on either side, thus forming a natural barrier of impervious material across the valley.

The dam, which will be 177 feet high above stream bed and 936 feet long, is designated as the Marathon dam, due to the fact that it lies in close proximity to the village of the same name, which is situated on the edge of the plains of Marathon. It will be constructed of marble from the foothills of Mount Pentelikon (which supplied the marble for building the Parthenon and other famous Greek structures) will impound about 11,000 million gallons of water. The dam is of the gravity section arch type (radius 1312 feet), about 154 feet wide at the base and 17 feet at the crest. The spillway is cut through the solid rock at one end of the dam, and a bridge will be built over this section so that the dam may be utilized as a link in a projected highway system. The elevation of the reservoir thus formed will enable the greater portion of the city of Athens to be supplied by gravity.

The topography of the intervening terrain between the Marathon reservoir and Athens is hilly and broken, and to construct an aqueduct on the hydraulic gradient would be costly and exceedingly difficult. The length of this aqueduct would perhaps be two or three times greater than the straight line distance between the city and reservoir. For this reason it was decided to bore a tunnel through the intervening hills, the outlet portal of which, after coming out on the plains north of Athens, will be connected to a pressure pipe line about six miles long for conducting the water to a concrete receiving and storage reservoir, located on the slopes of a hill overlooking the city. From this point the distribution system proper will begin for supplying Athens, Piraeus and their environs with water.

The Boyiati Tunnel will be 13,482 meters or 8.3 miles long and is being driven from two portals. The section of the tunnel will vary to conform to the ground through which it is driven. In the soft ground (clay and conglomerates) obtaining at the south portal, the tunnel is being lined with pre-cast concrete blocks as the heading is advanced. Six blocks are required to a ring, the bottom or invert block being flat and the arch or intrados curved to a radius of 5 feet such that the maximum width of the finished tunnel at the center line is $7\frac{1}{2}$ feet and the height also $7\frac{1}{2}$ feet. At the north portal, where the material varies from a soft to a hard schist the shale, a segmental three-arch timber support is required. This section of the tunnel will be lined

with concrete and when finished will be of horse-shoe shape $8\frac{1}{2}$ feet wide by 7 feet high. In case good solid rock is encountered, requiring no timber support and offering ample assurances as to its stability, the lining will consist of cement mixture applied to the virgin rock pneumatically. The finished dimensions of this section will approximate 9 feet wide by $7\frac{1}{2}$ feet high. The increased area of this section is calculated to compensate for the increased friction due to the rougher perimeter.

It is calculated that the tunnel when finished will have a discharge capacity of approximately 35 cubic feet of water per second. This quantity is about twice the estimated requirements of Athens and probably in excess of the average annual yield of the Marathon reservoir.

Test borings sunk along the tunnel line indicated that considerable water would be encountered; and, since construction work started, this has been borne out. The construction program as established fixes the "holing through" date during the middle of the year 1930, which corresponds with the completion of the dam and other portions of the undertaking.

Modern tools and equipment are being used. In the south heading pneumatic coal augers and spading tools are used, while in the north heading drifters and hammer drills are employed. High-pressure blowers discharging through a 10-inch pipe, supplemented by exhausters fans connected at the ground surface to the 8-inch test holes, supply the ventilation. The high pressure air is carried in a $4\frac{1}{4}$ -inch plain-end well casing line joined with compression type couplings. The tunnel is electric lighted and haulage is by means of trolley-type three-ton electric locomotives on 20-inch gauge track. The muck cars are all steel, of the rigid dump $\frac{1}{2}$ -cubic yard type and are dumped by means of rotary tipples. On account of cheap labor, hand mucking is employed.

At each portal is located a modern two-stage air compressor plant. All equipment is electrically driven except for surface haulage, where gasoline locomotives are employed. A central generating station, consisting of four 330-horse power Diesel engines, direct-connected to alternating current generators was constructed for supplying power. A three-phase 50-cycle 15,000-volt transmission line conducts the current to the dam and north and south portals of the tunnel.

Prior to the installation of the generating plant, portable air compressors were used in repairing the Hadrian aqueduct and turning the headings of the Boyiati Tunnel. A Sullivan "Turbinair" diamond core drill is employed at the dam for putting down grout holes. The north tunnel heading was turned August, 1926, and the south tunnel heading in October of the same year. August of 1927 was the first full month the north heading had available full power and equipment and during that month an advance of over 750 feet was made, using Greek labor which has been trained on the job. Two Americans are in charge of the north tunnel operations.

The following table shows progress in feet since August, 1927:

Month	North Portal	South Portal
September, 1927.....	784	650
October	892	600
November	862	626

December	830	574
January, 1928.....	683	459
February	404	341
March	478	397
April	433	430
May	748	541
June	1027	595

Total distance driven July 1, 1928..11,218 8,381

In a letter dated July 23rd, Ulen & Company say: "We believe the progress made for the month of June to be very near a world's record, because both the north and south portal were timbered, the north being in a soft rock while the south was in clay, sand and gravel which yielded considerable water. At both portals the timbering had to be carried close to the face. This record was made with native labor trained under the direction of four tunnel superintendents which we sent over from this country. The north heading required drilling while pneumatic spades were used in the south, both of the headings being driven without the use of shields."

In January, 1928, the north portal heading encountered extremely hard rock, while very wet ground was met in the south portal heading. This accounts for the sharp drop in progress.

The south portal is within a few hundred feet of the old aqueduct, where the slaves toiled under conditions that would not be tolerated today. The whirl of air compressors, the rat-a-tat of pneumatic drills, the resounding boom of dynamite, electric lights, locomotives, pumps and good ventilation contrast markedly with the conditions under which the old tunnel was built eighteen hundred years ago.

Swimming Pool Sanitation in Baltimore

A paper with the above title was read by M. H. Coblenz, chief of Division of Chemical Technology of the Bureau of Chemistry and Foods of the Baltimore Health Department, before the Maryland Water and Sewerage Association at a recent meeting. Mr. Coblenz discussed quite thoroughly experiences and tests made by the Baltimore Health Department.

It had been learned that all the swimming pools of the city are now using a competitive scoring system, which has stimulated a cooperation on the part of the operators which has helped materially to raise the sanitary quality from 67% to a maintained quality of around 90%.

The real problem had been found to be a study of the various types and layouts and the recommendation of sets of procedures peculiarly adapted to each pool. In most of the older type natatoriums, the matter of proper bather control is difficult of enforcement and is therefore the paramount one in swimming pool sanitation.

Their records showed that none of the ultra-violet ray equipments in the pools have, after thorough trial, been able satisfactorily to maintain the specified standards for bacterial quality of water, but those using chlorine as a sterilizing agent have generally all been able to maintain quality. The experience of the city has been that standards of chemical, physical and bacterial quality of pool water as recommended in the code can be readily maintained with the proper sanitary supervision, preferably by

health authorities, when chlorine is used as a sterilizing agent. The most satisfactory results are maintained, according to their records, by the more recently constructed natatoriums using automatically controlled chlorinating apparatus.

The chlorinating method employed consists of dissolving as thoroughly and quickly as possible the proper amount of commercial chlorinated lime in a bucket of warm water, filtering the solution through cheese-cloth and adding it to the pool by means of a funnel on the stem of which is attached a piece of rubber tubing held rigid by a stick. The tubing is of sufficient length to reach within a foot of the bottom of the pool at the deep end and the opening at the end of the tube is of such size as to

permit the solution to enter slowly. The temperature of the solution being warmer than that of the pool water, the chlorine makes its way towards the surface. The speed of adding the solution and the movement of the operator around the walk ways are so correlated as to make a complete round by the time the full amount of solution is used up. To obtain even distribution, the water is stirred as thoroughly as possible with a long pole after the solution has been added. The amounts of chlorine to be used are controlled by a La Motte pool testing outfit especially prepared for the residual chlorine and PH values. Residual chlorine tests are made hourly, and the result during the peak of bathing is the overall control.

New Sewage Disposal Plant for Durham, N. C.

Enlargement of existing plant to two million gallons capacity. Grit and screen chambers with self-cleaning screen, sedimentation tanks with sludge removal apparatus, trickling filters and sludge digester

By Preson P. Phillips*

Durham, North Carolina, is located on a ridge, and to avoid pumping is served by two sewage disposal plants, both of which are old and overloaded. The main plant is located on Ellerbee creek and takes care of all the trade wastes from the manufacturing plants of the city. Studies are now being made by the city, under the direction of the State Board of Health, to determine the best way to treat these trade and dye wastes coming from hosiery mills, cotton mills, tobacco plants, etc., of which there are many.

The smaller plant is located on Third Fork creek, about three miles from the city, and takes care of the southern section of the city, which is mostly residential. It is planned to have this plant care exclusively for domestic sewage, and any trade wastes that would naturally drain to this plant will be pumped to the main plant.

The present plant consists of a screen chamber a small Imhoff tank, sludge beds, dosing tanks, and sand filters with a combined area of one acre. This plant was built in 1915 and was designed for a maximum flow of 300,000 gallons per day from a population of 3,000. (The present population of the city is about 45,000.)

The population at present contributing to this plant is about 5,000, and it is estimated that it will be 10,000 within the next ten years. The present flow through the plant, as measured by hook gauges, is a minimum normal flow of 750,000 gallons per day, a maximum normal flow of 1,250,000 gallons a day, and a wet-weather flow of over 2,000,000 gallons a day. The three miles of outfall sewer to this plant is laid in very wet, marshy ground, and consequently infiltration has played a large part in overloading the plant. The old plant has given unusually good results up to and even beyond its maximum capacity, and the plant would have been enlarged using the same

type of treatment but for two factors, namely, the plant is on such low ground that it would have been very expensive to construct Imhoff tanks of any depth, and the area necessary for sand filters is not available.

In the fall of 1926, the Gilbert C. White Company was instructed to make the necessary surveys and submit a report on increasing treatment capacity. This was done, the State Board of Health assisting in the various studies that were made. Their report was accepted and the engineers were authorized to proceed with design and construction.

Studies were made of all the present methods used in treating sewage, with possibilities of adapting them for the use of the City of Durham. In designing the plant it was necessary that the first costs be kept as low as possible, that the plant take care of a variable flow efficiently, be capable of expansion to at least twice its present capacity, and be simple to operate.

The grit and screen chambers and the clarifiers are designed for a flow of from 700,000 to 2,000,000 gallons per day; the trickling filters and sludge digester are designed for a population of 10,000, and the sludge beds for a population of 5,000. All of these installations can easily be enlarged to almost any desired capacities.

In view of the fact that the water level in the present plant is only three feet above the normal creek level, pumping the raw sewage was at first contemplated. The creek is small, however, and by clearing its banks and cleaning it out for some distance downstream, and carrying the walls of all structures seven feet above the creek level, there is practically no danger of the plant being flooded, and this would permit the use of some of the existing structures in the new design.

Grit Chambers.—The sewage enters the plant through screen and grit chambers. The screen

* Designing engineer, Gilbert C. White Co.

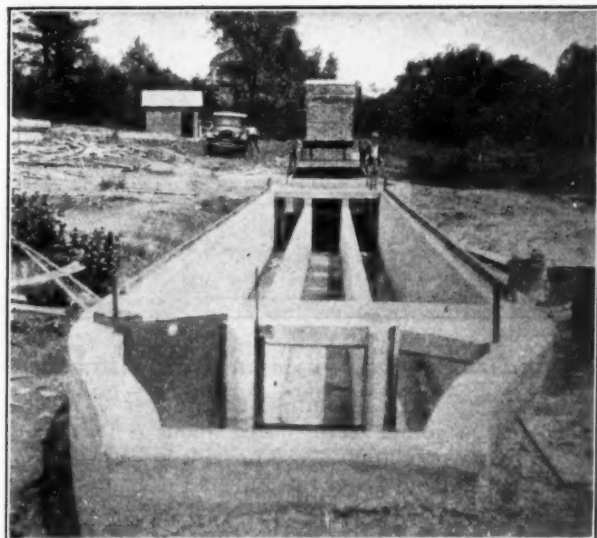


FIG. 1. GRIT AND SCREEN CHAMBERS

chamber precedes the grit chambers and is equipped with a self-cleaning Dorrco bar screen operated by a motor. The grit chamber is sixty feet long and is divided into three compartments each two feet wide. Each of these compartments will care for the minimum normal flow of 700,000 gallons per day, giving a detention period of 1 minute and a velocity of 1 foot per second. As the volume of flow increases, the other chambers can be thrown into operation, and all three can care for a maximum flow of 2,100,000 gallons per day. Gates are provided at both ends of the chambers so that any one may be cut for draining and cleaning. Separate drain with valve is pro-

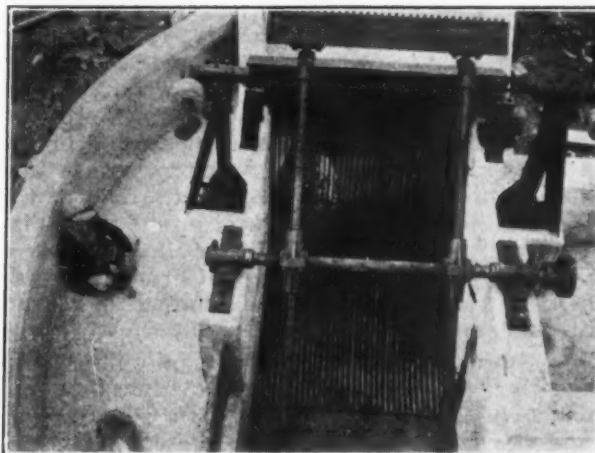


FIG. 2. DORRCO SELF-CLEANING SCREEN
Overflow bypass at the left

ternate designs for sewage clarification were prepared using Dorr clarifiers and Link Belt clarifiers. Two units of the Dorr type would be required, each having a capacity of 1,000,000 gallons per day; and three units of the Link-Belt type, each with a capacity of 700,000 gallons per day. The Link-Belt type was finally adopted for several reasons: the first cost to construct was less because the basins were long and narrow and the bottom could easily be reinforced to take care of the upward pressure of the ground water, while the Dorr type would have required a system of underdrains. The three units of the Link-Belt type gave greater flexibility in operation, each unit caring for the minimum daily flow of 700,000 gallons with a two-hour retention.

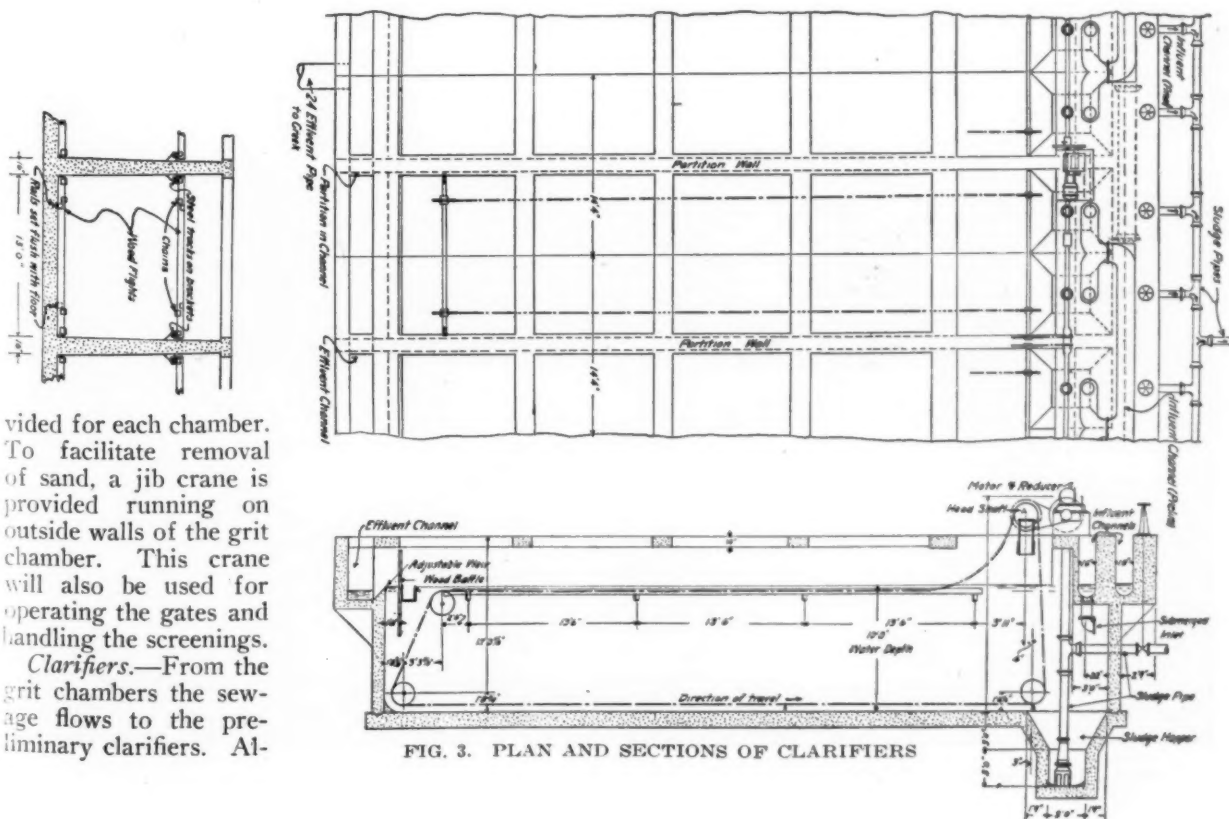


FIG. 3. PLAN AND SECTIONS OF CLARIFIERS

vided for each chamber. To facilitate removal of sand, a jib crane is provided running on outside walls of the grit chamber. This crane will also be used for operating the gates and handling the screenings.

Clarifiers.—From the grit chambers the sewage flows to the preliminary clarifiers. Al-

These clarifiers are the usual Link-Belt type, 13 feet wide, 58 feet long and 10 feet deep below the water line. Wood flights push the settled solids to sumps at one end of the tanks, from which they are forced by hydrostatic pressure to the sludge well. The return journey of the wood flights is just at the water surface and they push the scum to the opposite end of the tanks, where a scum trough is provided so that the scum can be flushed out and allowed to flow by gravity to the sludge well. From the clarifiers the clarified sewage flows through a venturi tube to a suction well.

The present Imhoff tank will be pumped dry and then filled with dry earth to the point that will give the proper capacity for a suction well, and the bottom paved. The present inlet weir is used as an overflow for the new suction well, and the present suction well, built at one end of the old Imhoff tank is being used as the new sludge well.

Dosing Tanks.—From the suction well the clarified sewage is pumped to dosing tanks located about twenty feet above the pumps and ten feet above the trickling filters. Twin dosing tanks are used in order that one tank may discharge completely before receiving fresh sewage and thus give a better distribution on the filter beds.

The trickling filters were so placed that the top of the present sand filters could be used as the bottom of the new trickling filters, the present embankments being built up and paved. The embankment paving is a six-inch reinforced concrete slab, cast in place, sides sloping at an angle of 45 degrees. A sidewalk five feet wide is provided on the top of all embankments so that the embankment will not stay muddy.

Concrete was mixed at a central mixing plant and carried around the top of the embankment to the point where it was to be placed. It was mixed very



FIG. 5. POURING SIDE WALL OF FILTER. 6 INCH SLAB ON 1:1 SLOPE POURED IN PLACE

dry so as to have a slump of not over 3 inches. Construction joints were placed about 6 feet apart but no expansion joints were provided. As the concrete was dumped from the top of the bank, it was caught on a board placed horizontal part way down the embankment and from this was distributed and tamped, and then screeded. Following the screeding, a top coat of very dry mortar was placed on the concrete. Using this method the wall on a one-to-one slope was placed with very little trouble, and a good, uniform surface was secured and maintained.

The floor of the filters slopes to the center drain and is covered with 6-inch split drain tile which is specially scored for better drainage. Seven feet of crushed stone running in size from 1½ inches to 2½ inches is laid on top of the drain tile, and the 6-inch supply pipes will be laid just under the top layer of stone without supporting piers, the nozzles being screwed directly into the pipes.

There are two filters with an aggregate area of slightly over an acre which will easily care for double the present population. Provisions have been made for flooding these beds, should it be necessary, or for putting one of the beds out of operation at the time for cleaning nozzles.



FIG. 4. TRICKLING FILTER UNDER CONSTRUCTION. 6-INCH SPLIT TILE UNDERDRAINS IN PLACE

From these beds the effluent will flow by gravity to the final clarifiers.

The *Final Clarifiers* are two in number, of the Link-Belt type exactly like the preliminary clarifiers, and in battery with them. Provisions have been made whereby these final clarifiers may be converted into preliminary clarifiers, at which time new final clarifiers will be built. These clarifiers are operated by the same motor that operates the preliminary clarifiers, and the water level in all the tanks is the same.

From these final clarifiers the sewage flows by gravity to the creek. No chlorination is contemplated at this time, but a manhole has been provided on the outfall line to the creek at which chlorine can be added should it become necessary.

The sludge and the scum from both the preliminary and the final clarifiers are led to a sludge well. Two Dorco diaphragm pressure pumps are used to force this sludge to the sludge digester.

The *Sludge Digester* is a concrete structure forty feet square and fifteen feet deep above the hopper bottoms, divided by concrete walls into four separate tanks each twenty feet square and having a capacity of 5,000 cu. ft. Each of these compartments has a hopper bottom and a separate inlet pipe, outlet pipe and overflow. The arrangement of piping and valves is such that the ripened sludge may be drawn from any one of these tanks by gravity to the sludge beds, or can be led back to the sludge well and mixed with fresh sludge to be pumped into any other tank, thus speeding up the process of digestion. The supernatant liquid is led to one end of the sludge bed.

The tanks as they are being built are designed for a capacity of 2 cu. feet per capita for a population of 10,000. They are so designed that a gas collector can be built on top; and if the gas is collected and used for heating the tanks, their capacity will be about doubled.

The *Sludge Bed* is 80 feet by 125 feet, giving 2 sq. ft. per capita for the present population. A concrete retaining wall was built around the entire bed high enough to prevent high water from the stream flooding it. This area is divided by boards into compartments 25 ft. by 80 ft., having separate inlets from the sludge digester.

The dried sludge will be removed from these beds by two travelling cranes, hand operated, forty foot span and twelve foot hoist, each having a capacity of one-half ton. Two loading ramps are provided at the end of the beds, and the dried sludge will be loaded directly into trucks. These cranes will be built in time to be used by the contractor for distributing his stone and sand over the beds.

There is plenty of space available for the expansion of these sludge beds, although it is probable that their capacity will be increased, when it becomes necessary, by covering them with glass.

The existing pump house is being used to house the new Dorco diaphragm sludge pumps. A new pump house is being built adjacent to it to

house the new clarified sewage pumps (which are being furnished by the American Well Works Company) and also the recording register for the Venturi tube.

The site of this plant was too far from a water main to make city water available for either construction purposes or operation. A small pump house and suction well was built adjacent to the stream, and a Duro pressure pump installed, with a 525-gallon tank. This was used by the contractor to supply his water for construction purposes. Small pipe lines will be run to all structures that will need cleaning, and hydrants will be installed and this pump used for supplying the pumps with water and for cleaning the various structures.

A Morse-Boulger incinerator capable of handling 100 pounds of wet screenings per hour is being provided adjacent to the screen chamber to be used for burning the screenings.

Since it is not the policy of many cities in the south to provide many or skilled caretakers for sewage disposal plants, an effort was made in the design of this plant to make it as simple as possible and to provide mechanical equipment practically throughout, and it is thought that this plant can be operated with the very minimum of labor, probably with the maximum of an operator and two laborers.

Consulting engineers:—Gilbert C. White Company, Durham, N. C.; Designing engineer:—Preson P. Phillips; Resident engineer:—Paul E. Tignor; Contractors:—The McClelland Company, Charlotte, N. C.

Sewage Treatment At Columbus

During 1927 the Columbus, O., sewage treatment plant was operated 191 days, or a little over half the time. During the time of operation the tanks removed an average of 94% of the settleable solids and 57.7% of the total suspended solids from the crude sewage. The retention period in the tanks average 4.2 hours and they reduced the bio-chemical oxygen demand 36.4%.

The sprinkling filters retained 30.7% of the suspended solids in the tank effluent, decreased the bio-chemical oxygen demand 68.8% and produced 2.4 parts per million of nitrogen as nitrites and nitrates.

The whole system reduced the total suspended solids 70.7% and the 5-day bio-chemical oxygen demand 80.8%. The average bio-chemical oxygen demand of the crude sewage for the year (seven months of operation) was 203 parts per million; that of the tank effluent 125 parts, and that of the sprinkler effluent 39 parts. The b. o. d. in the crude sewage varied from a minimum of 161 p. p. m. in July to a maximum of 233 parts in September; while that of the sprinkler effluent varied from a minimum of 27 in June to a maximum of 45 in May.

During the year some investigations were made to determine the effect of chlorine treatment on the bio-chemical oxygen demand of the filter effluent. In making these tests, the immediate chlorine demand was determined and the amount of chlorine added was equivalent to this less 0.2 part. The underdosage was for the purpose of preventing sterilization of the sample. Forty-five determinations were

made for one-day, two-day, three-day, and five-day demands. The amount of chlorine added averaged 2.11 parts per million. The average b. o. d. of the untreated effluent for one day was 14.2 p. p. m., for two days 20.7, for three days 25.9, and for five days 33.0. That of the treated effluent was 4.9, 10.2, 15.0, and 19.3 respectively; giving a percent reduction of 65.5% in one day, 50.8% in two days, 42.1% in three days, and 41.5% in five-day demand.

Sewage Treatment Abroad*

Gas collection installations in Holland and Germany. Latest developments in Imhoff tanks in the Ruhrverband

By Willem Rudolfs

GAS COLLECTION

Accurate and systematic studies on gas production and gas collection from sewage, trade wastes, and sludges were first made in Holland under the direction of Kessener. The first large scale application was constructed by him at Sappemeer (1909) where strawboard mill waste was treated.⁸ The gases were collected and used for driving a 140 h.p. motor. Some of the gas was sold to the city.

The installations followed each other quickly. One was in operation at Voorburg, where the gas was collected from domestic sewage sludge in 1914. Another at Oude Pekela in 1915, Hoogkerk in 1916, Boxmeer in 1917, etc. Figure 6 shows the reconstructed gas domes at Sappemeer in 1913. Figures 7 and 8 show the construction details as well as completed covers and gas collectors used since 1915 at Oude Pekela. The covers are made of reinforced concrete and function as ordinary floating gas holders. Gas production and gas collection was perhaps most thoroughly studied by Kessener at Oude Pekela on warm beet sugar waste. The effect of changes in temperature of the waste, concentration of the waste, effect of detention, etc., upon gas production was studied. The gas was metered, passed through a self registering calorimeter to determine the heat value, and was then used for pumping, gas oven, distillation of water, and other laboratory purposes. The gas collectors put into operation last year at Birmingham,⁹ England are copies of the floating gas holders at Hoogkerk.

The separate digestion tank at Essen-Rellinghausen, which receives the partly digested sludge from the Imhoff tanks and surplus activated sludge, is covered with a wooden cover and a so-called water seal (fig. 9). This submerged wooden cover has slots which lets the gas through and keeps the scum down. These wooden racks with slots have been tried recently in this country; some had to be removed on ac-

*Continued from page 268.

⁸Rept. Com. for purification of waste, 1912.
⁹The Surveyor, Dec. 5, 1927.

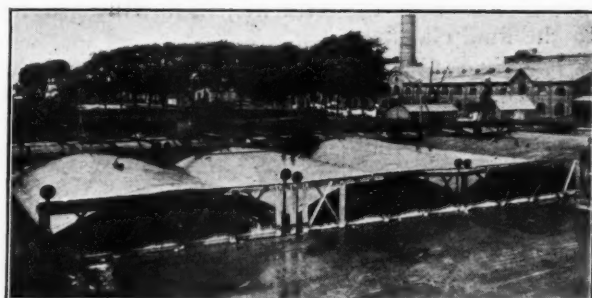


FIG. 6. GAS COLLECTORS ON TANKS FOR STRAWBOARD WASTE TREATMENT AT SAPPEMEER, HOLLAND

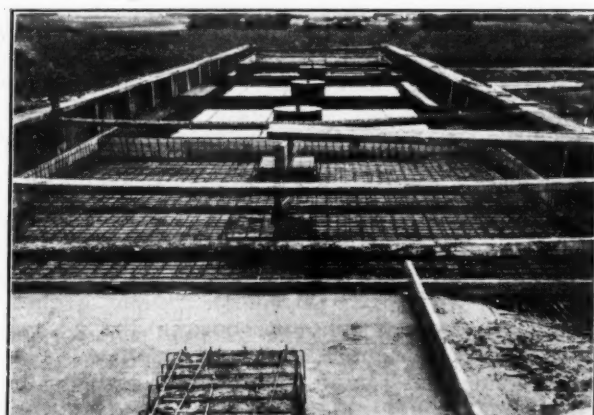


FIG. 7. CONSTRUCTION OF COVERS AND GAS COLLECTORS AT OUDE PEKELA, HOLLAND



FIG. 8. GAS COLLECTION FROM SUGAR WASTE TREATMENT PLANT AT OUDE PEKELA

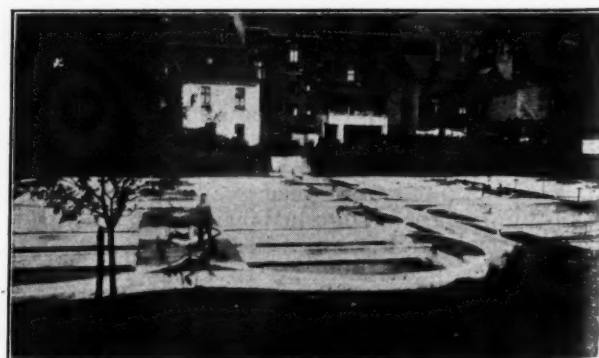


FIG. 10. PROXIMITY OF HOUSES TO IMHOFF TANKS AT STEELE, GERMANY

count of clogging. A floating cover with a gas collector in the middle, developed in this country by Downes at Plainfield, is about between Kessener's and Imhoff's covers and gas collectors.

IMHOFF TANKS

Nearly all the accessible two-story plants operated under direction of Dr. Imhoff in the Ruhrverband were visited. Those who have visited these plants have been struck by the neat appearance, the absence of odors, and in some cases the proximity of houses. The plant at Steele (Fig. 10) is a good example of the proximity of houses. This plant treats a sewage which is diluted considerably with ground water and pump water from coal mines. The result is a weak sewage containing much grit and coal dust. The sludge produced at this plant is very thick and very finely divided. Another striking example of proximity of houses is the plant at Dahlhausen (fig. 11) located in the center of the town where the market place used to be. There is no possibility of sludge drawing and the sludge is being pumped during the night into tanks and transported out of town. Neatness of appearance has apparently been recognized to be of value, because at all the older plants flowers and shrubbery bloom profusely during the summer months. Practically everywhere the walls of

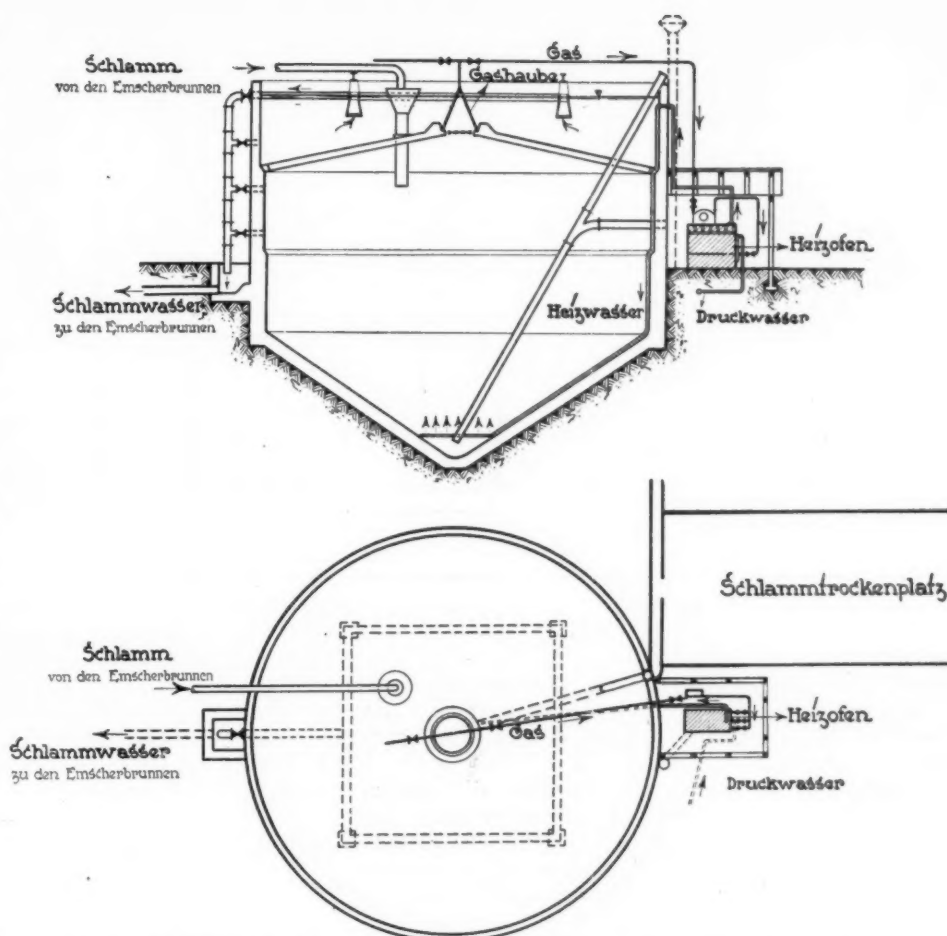


FIG. 9. PROVISION FOR GAS COLLECTION ON DIGESTION TANK AT ESSEN-RELLINGHAUSEN

Schlamm von den Emscherbrunnen=sludge from the Imhoff tank. Schlammwasser zu den Emscherbrunnen=sludge water to the Imhoff tank. Gashaube=gas hood. Heizwasser=hot water from the heater. Heizofen=gas heater for heating water. Schlammtrockenplatz=sludge bed.

tanks are whitewashed above the water line (fig. 12); as a matter of fact, all conduits and all concrete work is kept clean and white.

One of the newer designs of Imhoff tanks, incorporating all up to date construction ideas, is at Neviges (fig. 13). The tanks are covered and gases collected. Not less than eight out of twelve Imhoff plants visited had submerged contact aerators installed, and at eleven places the gases were collected. At Iserlohn an attempt is made to heat the digestion compartment of the Imhoff

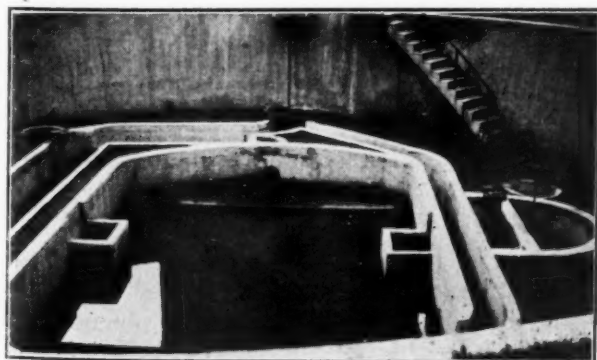


FIG. 11. IMHOFF TANK IN CENTER OF TOWN OF DAHLHAUSEN

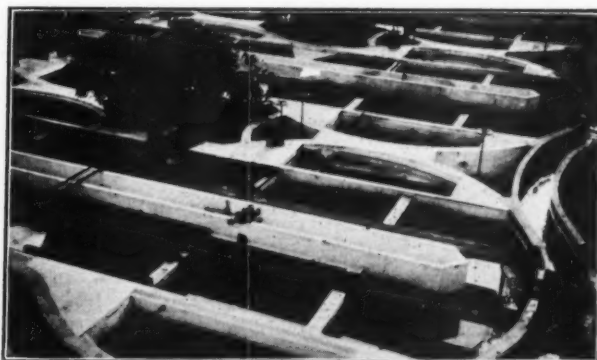


FIG. 12. EXAMPLE OF NEATNESS OF APPEARANCE OF IMHOFF TANKS (ESSEN-RELLINGHAUSEN)

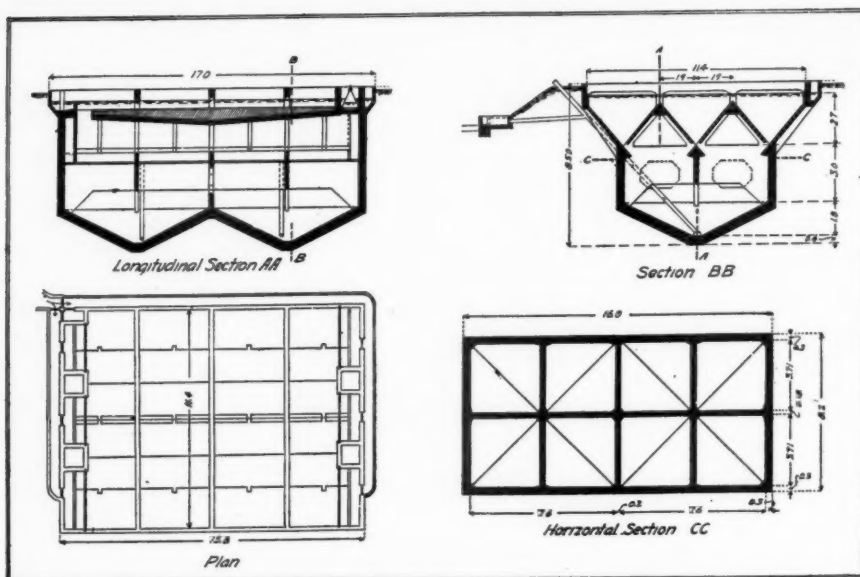


FIG. 13. ONE OF THE NEWER DESIGNS OF IMHOFF TANKS (NEVIGES)

tanks with hot water, the water being heated by burning the gas from the tank. No heating coils were used but hot water was introduced into the digestion chamber, similar to the separate digestion tank at Rellinghausen.

From all appearances it seems that difficulties frequently encountered in this country with the operation of Imhoff tanks are practically absent in the Ruhr district. It is intended to discuss in a following paper some factors which may play a role in these differences of behavior.

Texas Sewage Research Laboratory

To meet the need for sewage research work that will be particularly applicable to the needs of Texas and the Southwest, a sewage research laboratory

has recently been established by the Texas Engineering Experiment Station at the Agricultural and Mechanical College of Texas. The research work will be under the general supervision of Dr. F. E. Giesecke, director of the Engineering Experiment Station, and will be directed by E. W. Steel, Professor of Municipal and Sanitary Engineering. P. J. A. Zeller, who was for three years a chemist with the New Jersey Sewage Experiment Station, has been appointed research associate. Work is planned and under way along the following lines: stream pollution; investigation of the Dunbar filter, fertilizing

Kansas Sewerage and Water Supply

The cities of Kansas have built 129 municipal sewer systems and one city is served by a company-owned system. Bonds totalling \$1,347,758 were issued by 31 cities during the year 1927 for sewer systems.

There are 276 municipally owned water plants in Kansas, and an average of ten cities install systems each year.

Maintaining Baltimore's Sewers*

Necessitated by poor design or construction, depreciation or misuse. Preventing entrance into sewers of objectionable materials. Methods, appliances and personnel for removing obstructions.

By Milton J. Ruark †

The need for maintaining sewers and drains is usually the result of one or more of four causes: Poor design, poor construction, depreciation, and—in some respects the most important of all—misuse.

Poor Design.—The question of the poor design of sewers in Baltimore, where careful study and thought are devoted to relatively unimportant sewer projects, is practically of no importance in so far as the maintenance of the sewers is concerned. Care must be given in selecting the proper materials for construction, and sewers of adequate sizes and strength should be planned. Except where unusual problems present them-

selves, the planning of sewers and drains has become so standardized that there is little excuse for poor designs.

Poor Construction.—It is as essential to have good construction as it is to use careful design in order that maintenance costs may be kept at a minimum. Two of the most essential things to watch in the construction of sewers is to see that the material used for backfill is thoroughly compacted under and around the pipe and that the joints are well made. The former precaution will add much to the strength of the sewer, and tend to prevent failures.

Tight joints not only reduce the quantity of ground water entering the sewers to a minimum but also help to exclude tree roots. Fully 35 per cent of the chokages in the sanitary sewers of

* Paper before the Maryland Water and Sewerage Ass'n.

† Sewerage Engineer, Bureau of Sewers, Baltimore, Md.

Baltimore are due to the roots of poplar and willow trees. Many times roots grow long distances to reach sewers. The roots of oak and similar shade trees have never been known to give this trouble. In each place where a sewer becomes choked because of tree roots the joints through which the roots have passed are remade with great care. First, a ring of jute is inserted in the bell of the pipe the same as when the usual Portland cement joint is made. Then red puddle clay, to which has been added a liberal quantity of coarse salt, is packed over the jute to within about one-half an inch of the end of the bell. On top of this is placed a mortar of cement and sand. This type of joint has proved effective, since none has ever been replaced because of the entrance of tree roots. Fortunately, this problem is getting better, as there is now a city ordinance which prohibits the planting of poplar trees on public highways.

Depreciation.—The maintenance required to keep a sewerage system in first-class condition is usually not great, especially if the system is new. However, there are numerous factors which tend to increase the gradual depreciation of sewers. Other public utilities such as gas and water pipes, electric conduits, etc., are often constructed in trenches adjacent to the sewers, and not infrequently the latter are damaged due to a settlement of earth of other causes. It is sometimes weeks or months before the trouble is discovered and rectified.

The tapping of sewers by plumbers to provide for additional house connections often causes trouble that makes itself evident by a chokeage near the tap. One way to remedy this difficulty is to inspect thoroughly every new connection.

A great deal of the general maintenance work consists in replacing noisy and broken manhole covers and making repairs to inlets. Where sewers are well designed and constructed, and are not old, little money need normally be appropriated or spent to remedy wear and tear.

Misuse.—Although a sewerage system is designed to have a very limited use, it usually becomes the repository for almost every conceivable object of moderate size. The following is a list of some of the things which have been removed from choked sewers: Hatchets, bricks, bird cages, corn cobs, flat irons, pick handles, dish pans, shoes, oyster shells, table spoons, broom handles, whiskey flasks, brushes, garden hose, coffee pots, dead cats and dogs, dolls, etc. It seems inconceivable how some of these objects get into the sewers. For example, pick handles, which are frequently found in sanitary sewers, have most likely been left there by some laborer after the completion of the sewers.

MAINTENANCE OF STORM DRAINS

One of the first rules that must be followed in order to reduce the maintenance of storm drains is to keep the streets clean. Unless this policy is followed, the debris on the street is washed into the drains after the first heavy rain, where it often has to be removed at considerable cost.

Some few years ago quantities of dead fish, which decomposed and gave off odors, were found

in the drains adjacent to some of the markets. It was learned that these fish were washed into the storm sewers, usually late at night, when the markets were being cleaned. Since this practice naturally created a good deal of trouble, the markets were patrolled for a short length of time, and the difficulty was remedied.

Disposal of Snow Into Drains.—In most large cities the disposal of snow into storm drains has become a generally accepted practice. Frequently the snow has mixed with it garbage, ashes and debris found on the streets. The snow melts in the drain and often leaves these foreign materials, which eventually have to be removed, stranded on the bottom of the sewers. Large drains should be selected for the disposal of snow and liberal quantities of water used for flushing purposes. A 36-inch drain in Centre Street became completely blocked with frozen snow last winter, and considerable difficulty was experienced in removing the material.

Disposal of Oil and Gasoline in Drains.—One of the most serious problems that confronts engineers who have charge of the maintenance of sewerage systems relates to the disposal of gasoline and oil from automobile crank-cases into the sewers. The problem is an ever present one not only in Baltimore but also in practically every large municipality in the country. Many cities have had serious explosions because of the ignition of gasoline in the sewers. On June 8, 1926, there was an explosion and fire in the Jones Falls drain, but fortunately, no serious damage resulted.

Immediately after the fire, efforts were made to enforce the ordinance which prohibits the discharge of oil and gasoline into the sewers. Many inspections were made of those drains and sewers tributary to that portion of the city where there were large numbers of automobile establishments. As it was impossible to police each public garage in the city, conditions were not improved. It was recognized that the only remedy was to provide the garages a way of disposing of the spent crank-case oils. As a result the city entered into a two-year contract with the Provident Oil Service, at a cost of \$3,240 a year, for disposing of the oil from garages and similar places. This company collects the oil at regular intervals and disposes of it.

CLEANING LARGE DRAINS

A minimum of time and money is spent in order to remove the material which settles in large drains. The velocities in them during dry weather are such that there are considerable deposits. The first heavy rain, however, flushes out this sediment, and the problem solves itself.

As a general thing there are practically no odors coming from storm drains. Occasionally there are odors from a few inlets, caused by a dead animal or other decomposing material being present. Disinfectants and deodorants are used at times when odors are pronounced.

There are certain drains and also sanitary sewers, the design and construction of which require frequent inspection and attention to see that they are in good working order. Where

the grades are flat, the deposits are removed, and where the drain is rapidly deteriorating, repairs are made. By having regular inspections made of these drains, much trouble is obviated. A group of five men with one truck devote all their time to cleaning large storm sewers and reporting their condition.

MAINTENANCE OF SANITARY SEWERS

The maintaining of the sanitary sewers usually consists of removing obstructions from the smaller pipes—usually 8 and 10 inches in diameter. On rare occasions a 12-inch sewer will become clogged, and only once or twice during recent years has a 15-inch sewer been obstructed. Where the larger sewers require cleaning, it is usually due to wastes from industries. As is the case with oil, adequate means where possible should be provided to dispose of this waste material other than in the sewers. Much can be done in a co-operative way. For example: Baltimore has a number of factories where tomatoes are canned. Many of these establishments used to dispose of the tomato skins into the sewers until they were notified that this practice was illegal and created considerable trouble at the sewage works.

All obstructions in main line and house sewers up to the building line are removed by the city. On the other hand, chokages in the house sewers inside the property lines are removed by a plumber employed by the property owner. This rule, although a rigid one, is not necessarily adhered to in emergencies. In case the difficulty is due to the carelessness of the property owner he is required to pay for all of the expense involved.

The majority of sewer obstructions are in those sections of the city with a large foreign population. In Roland Park, for instance, the number is relatively small in spite of the fact that many of the sewers are 6 inches in diameter, and are built in curves between manholes.*

The sanitary sewers of Baltimore are free from objectionable odors. The reason is that sewers have good grades, and are ventilated by the house stacks on each building. Sewers that are free from odors because of good ventilation are good insurance against explosions. Moreover, they can be cleaned without hazard to workmen.

*The Roland Park system was built as a private system prior to Annexation. The city does not construct lateral sewers less than 8 inches in diameter.



TWENTY-FOUR HOUR EMERGENCY SERVICE TRUCK, WITH TOOL BOXES, FOR SEWER MAINTENANCE

CLEANING TOOLS

A wise selection of cleaning tools greatly decreases the cost of maintaining sewers. The first essential is to have good cleaning rods. Two types are used in Baltimore. Jumbo Rods No. 10, which are used to clean out storm drains, are made of wood, 3 feet long, octagonal in shape, and about 2 inches thick. They have the advantage of being strong, and at the same time sufficiently light to float on the water while they are being shoved through the drain.

The other rods, which are used to clean sanitary sewers, are 4 feet long with a cross-section of $1\frac{1}{8} \times \frac{7}{8}$ inches. Other tools, such as scoops, root cutters, etc., are also of value. One of the greatest time and money saving devices for cleaning sewers has been flexible steel cables. They are narrow but strong ribbons of steel, which are used primarily to clean house sewers. At the end of the cable there are two small steel rollers, which increase the ease with which it can be forced through the sewer. The use of this cable has saved property owners thousands of dollars, which formerly was spent in tearing up and replacing the sewers.

PERSONNEL

The cleaning of the sanitary sewers and storm drains is under the supervision of one man. As previously stated, there is one gang of 5 men with a truck which spends all of its time in cleaning large storm drains. There are 4 additional gangs with 4 men in each gang—each provided with a truck—which clean inlets, report and replace broken and noisy manhole castings, and watch for the disposal of oil in inlets. Each of these gangs is allotted a section of the city, which it periodically patrols and is responsible for. There is, moreover, a gang of 9 men, which makes repairs both to storm drains and sanitary sewers.

The sanitary sewers are maintained by 9 groups of men. Four of these groups, consisting of 18 men and 2 foremen, relieve chokages on main line sewers, while the remaining 5 groups, having a total of 10 men and one foreman, relieve house sewer chokages. In addition to the above force, there are 2 men who are on duty on Sundays and holidays and also each day from 4 P. M. until midnight. They take care of any emergency that arises after working hours.

The total cost of maintaining 1,560 miles of sanitary sewers and storm drains during 1927 was approximately \$158,000. Of this amount \$65,500 was spent on 1,000 miles of sewers and house connections at a cost of \$65.50 per mile, and \$92,500 on 560 miles of drains at about \$165 a mile.

CONCLUSION

The public usually gets its impression as to the efficiency of the department in charge of the sewerage system not so much because the system has been well designed and constructed as because of the speed with which a noisy manhole cover is replaced, flooded cellars are pumped out, and obstructions in sewers removed. Efficient service is demanded, and every effort should be made by municipal authorities to give it.

Garbage Disposal in Albany

Albany, New York, garbage is now disposed of to farmers, four trucks owned by the Department of Health collecting about half of it, while one third is

collected by two contractors and the remainder by 45 licensed collectors. The city has recently received bids for a garbage incinerator and when this has been completed, supervision of the collection of garbage will be transferred from the Health Department to the Department of Public Works.

Syracuse Garbage Reduction Plant

The city of Syracuse several years ago obtained from the C. O. Bartlett & Snow Company a Cobwell garbage reduction plant, and entered into a five year contract with the company to operate the plant.

This contract expired on May 1 and at the date of

expiration the city and the company had not agreed upon terms for a renewal of the contract. As it was necessary to keep the plant operating to dispose of the city's garbage, it was placed temporarily in charge of William Gyatt of the engineering staff of the Intercepting Sewer Board. Mr. Gyatt operated the plant for about two months, at the end of which time the city and the company had come to an understanding and a new contract has now been entered into under which the company will operate the plant and will also build an incinerator to dispose of corn cobs and other materials in the garbage which are not desirable in the digestion plant and also of a certain amount of rubbish.

Imperviousness and Run-Off to Sewers

Actual measurements of rainfall and run-off to sewers in Manchester, England, indicate that impermeability of an area is a reasonably accurate guide to percentage of run-off

Considering the wide and important use made of the rational method of designing storm sewers, and the importance of the factor of imperviousness in using such method, it is somewhat remarkable as well as unfortunate that there have not been more actual measurements made of run-off from different classes and conditions of municipal areas and a check of these against the calculated imperviousness of such areas.

In a paper before the Centenary Conference of the Institution of Civil Engineers of Great Britain, J. B. L. Meek, city engineer of Manchester, England, presented actual measurements and calculations made in connection with the designing of intercepting sewers for that city which give information of this nature.

Records of rainfall as registered by an automatic gauge had been taken since 1899 and are still being taken, and these records were used for plotting a curve of rates of rainfall to be anticipated. In studying the relation between percentage of impervious surface and density of population, three areas were selected covered with different classes of property and housing different densities of population. The impermeable areas, such as streets, roofs, yards, and garden paths, were then actually measured and

their relation to the whole area were then computed. From these three areas a curve was plotted, which was used to determine the percentage of impervious surface of any area whose density of population is known. In the first area there were 5.45 houses per acre, housing 31 persons, and the impermeable area was 42 per cent of the whole. In the second class there were 14.95 houses per acre, housing 75 persons, and the impermeable area was 75 per cent of the whole. In the third area there were 21.18 houses per acre, housing 100 persons, and the impermeable area was 90 percent. Through these three points a curve was plotted as shown in the illustration.

In checking up on the relation between imperviousness of area and percentage of rainfall reaching the sewer, four areas differing in character and population were selected. All inlets to the sewers in each area were traced, in order to be certain that only the drainage from the selected area was entering the sewers. A weir was built at the outlet of the area and a self-recording gauge was fixed from which the quantity of storm water was calculated. The dry weather flow was learned and deducted from the total flow. Each rainfall was gauged by means of the automatic recorder and the quantity falling was compared directly with the run-off.

The Victoria Road drainage area has a total area of 28.9 acres, with 521 houses, or 20.75 per acre and a population of 91.6 per acre. 25.1 acres had an

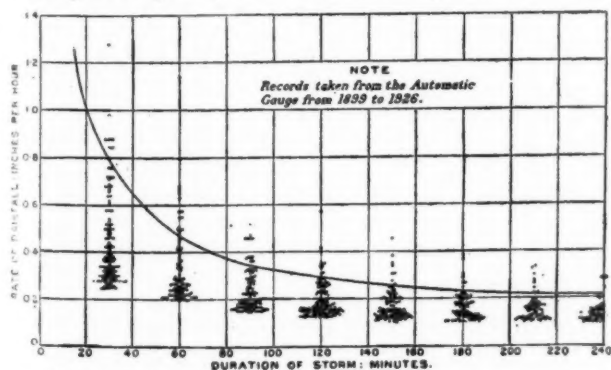


FIG. 1—RAINFALL CURVE USED IN CALCULATING RUN-OFF

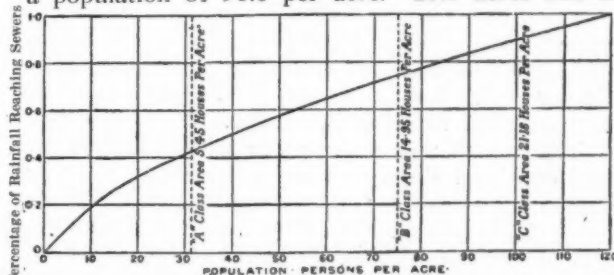


FIG. 2—RATIO BETWEEN PERCENTAGE OF RAINFALL REACHING SEWER AND POPULATION PER ACRE

impermeability of 88 per cent, and the remaining 3.8 acres of 56 per cent, giving an average impermeability of 84 per cent. From observation extending over 12 months, the measured percentage of rainfall reaching the sewer was found to be 78.5 per cent, and if the curve of figure 3 is produced from this point, it reaches the calculated percentage of 84 for the maximum rainfall rate of 1.1 inches per hour, the rate for a 17-minute concentration period as indicated by figure 1.

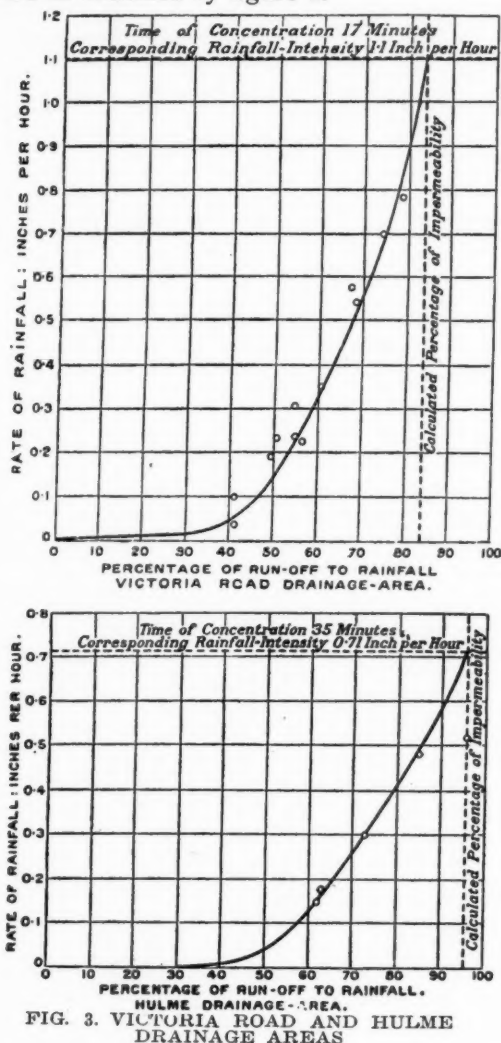


FIG. 3. VICTORIA ROAD AND HULME DRAINAGE AREAS

The second was known as the School Lane area, which was a less populous suburban area. It contained $59\frac{1}{4}$ acres, with 12.42 houses and 58.4 persons per acre. The impermeability was calculated at 63 per cent. Percentage of rainfall reaching the sewer was found to be 61 per cent.

The third, known as the Vale Street area, contained 32.85 acres, and 9.5 houses or 44.65 persons per acre and the impermeability was found to be 54 per cent. The gauge showed 53 per cent of the total rainfall reaching the sewer.

The fourth area was known as the Hulme area and consisted almost entirely of working class and industrial property with a population of 151 per acre. This area was almost entirely impervious, and the percentage of rainfall reaching the sewer was 95.5. This would seem to indicate that even in a wholly impervious area all of the rainfall does not

reach the sewer, which is the conclusion arrived at by most engineers in this country.

Mr. Meek concludes from these measurements, although they are as yet incomplete, that they "indicate that the measure of impermeability of an area is a sufficiently accurate guide to the percentage of rainfall reaching the sewers from that area. . . . It would be of immense assistance if in all towns with a population exceeding 10,000 persons, the records were kept of at least one automatic rain gauge. The expense would be very small compared with the advantage of possessing data enabling an area to be scientifically drained when the necessity arose."

Cantilever Testing Apparatus for Mortar Beams*

By D. O. Woolf†

The Division of Tests of the Bureau of Public Roads has recently designed an apparatus for testing cement mortar beams under cantilever loading which is similar in a general way to that developed by the Illinois Department of Public Works for tests of concrete and described by H. F. Clemmer in the May, 1926, issue of *Public Roads*. The apparatus was designed to furnish a more rapid method of testing mortar beams in flexure and which could be employed in laboratories not equipped with a universal testing machine of sufficient sensitivity to test such beams.

The apparatus consists of a clamping device to hold the beam securely and an extension arm which fastens on the end of the beam and transmits the load. The beam may be loaded by any means that is at hand. In the bureau laboratory, No. 12 lead shot are used to apply the load. The shot are fed from a reservoir fastened to the wall, and equipped with a quick-action valve which opens completely by moving the control handle through a 60° arc.

The two thumbscrews shown in the clamping device bear on a steel plate three-eighth inch thick, which rests on the specimen. The beam is tested in the same position that it is molded, i. e., with the troweled surface up. Slight irregularities in the troweled surface have prevented an even distribution of stress over the surface exposed to restraint, and have consequently given poor breaks with an accompanying wide variation in test results. To overcome this, a piece of sheet rubber one-eighth inch thick is placed between the bearing plate and the specimen. This has given very good results.

The test specimens, 2 by 3 by 12 inch beams, are made in steel molds. The use of such molds, with carefully machined surfaces, is considered highly advisable.

* From "Public Roads," journal of the U. S. Bureau of Public Roads.

† Junior materials engineer, Division of Tests, U. S. Bureau of Public Roads.

Computations of the modulus of rupture are made using the formula

$$S = \frac{Mc}{I}$$

where

S =modulus of rupture, in pounds per square inch,
 M =bending moment in inch-pounds, $=W_1 l_1 + W_2 l_2$

where

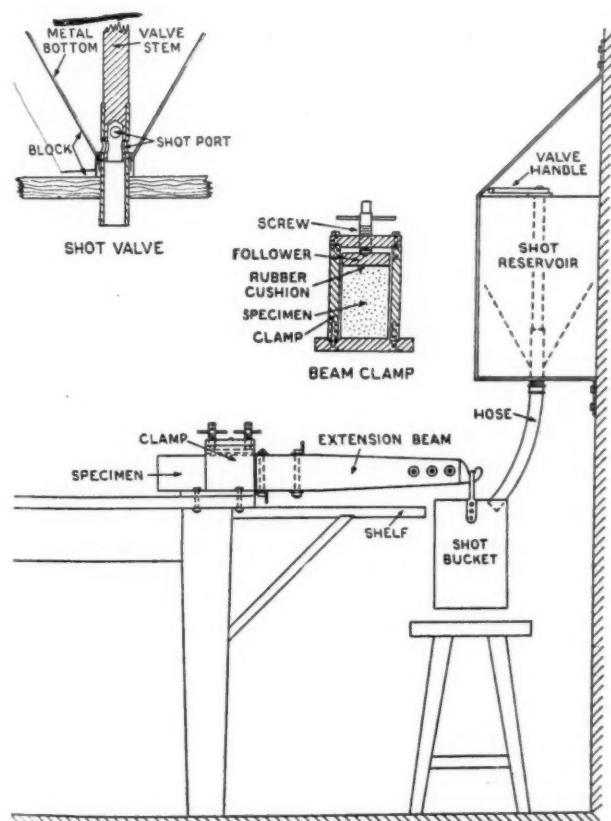
W_1 =test load, in pounds
 l_1 =distance of load from support=18.12 inches,
 W_2 =weight of arm,
 l_2 =distance of center of gravity of arm from support,
 c =distance of extreme fiber from neutral axis, or $1\frac{1}{2}$ inches,
 I =moment of inertia of cross section of beam about its central horizontal axis.

Substituting the particular constants which applied for these tests, and neglecting the weight of the overhanging beam we have,

$$S = 12.4 + 6.04W_1 \text{ (pounds per square inch)}$$

Neglecting the weight of the overhanging section of the beam is in accordance with the usual practice in testing beams for flexure under center loading.

To demonstrate the suitability of this apparatus for testing beams, four series of beams were prepared for comparative tests in the cantilever apparatus and in a universal testing machine under center loading. Each series included five or six 18-inch beams for test under center loading, and an equal number of 12-inch beams for test in the cantilever apparatus. Series B, C, and D were made of a 1 : 3 mix and series A of a 1 : 2 mix using Potomac River sand in all series. Series A was tested at an age of 14 days, series B at 28 days, and series C and D at 7 days.



APPARATUS FOR TESTING BEAMS AS CANTILEVERS

The various series were made in the laboratory as time permitted. Because of the small number of molds available, no effort was made to tie the four series together. In series A, each specimen was made from a separate batch, the 18-inch beams being made first. Inspection of the test results of this series indicates that the water-cement ratio may not have been exactly constant for the two sizes of beams. When tested as cantilevers, the halves of the original 18-inch beams check the center loading tests, whereas the 12-inch beams tested as cantilevers show somewhat lower values. To guard against this, and to furnish a better comparison between the two methods of testing, in series B, C, and D each 18-inch and the corresponding 12-inch beam were molded simultaneously from the same batch.

The 18-inch beams were tested in an Olsen universal testing machine of 40,000 pounds capacity. A small beam rider was used which decreased the machine ratio by 10, and permitted accurate reading of the applied load to the pound. A span of 15 inches was used and the beams were mounted on rockers in accordance with approved practice. The rate of application of the load was such that the modulus of rupture developed at an average rate of about 100 pounds per square inch per minute. The broken halves were then tested in the cantilever apparatus to serve as a check. These last tests are shown in Tables 3 and 4.

The 12-inch beams were tested in the cantilever apparatus, applying the load at a rate of 15 pounds per minute. This produced a stress increasing at the rate of 102 pounds per square inch per minute. Two breaks were made on each beam. The beam was inserted in the clamping device and the extension arm hung on the free end of the beam. The beam was then so adjusted that the base of the extension arm was one-sixteenth of an inch from the clamping device. This space is the minimum sufficient to permit flexure without binding. The beam was then firmly fastened and loaded to failure. The breaking load was weighed to the nearest tenth of a pound.

TABLE 1.—Results of tests under center loading in universal machine using 15-inch span

Modulus of Rupture			
Series A, mix 1:2, age 14 days Lbs. per sq. in.	Series B, mix 1:3, age 28 days Lbs. per sq. in.	Series C, mix 1:3, age 7 days Lbs. per sq. in.	Series D, mix 1:3, age 7 days Lbs. per sq. in.
608	519	400	385
544	525	395	454
520	525	394	431
495	474	400	415
547	...	476	398
Av. 543	Av. 511	Av. 413	Av. 417

TABLE 2.—Results of tests of 12-inch beams in cantilever apparatus

Modulus of Rupture			
Series A, mix 1:2, age 14 days Lbs. per sq. in.	Series B, mix 1:3, age 28 days Lbs. per sq. in.	Series C, mix 1:3, age 7 days Lbs. per sq. in.	Series D, mix 1:3, age 7 days Lbs. per sq. in.
526	533	432	447
508	522	459	432
535	475	396	417
547	519	396	426
481	525	396	411
526	503	370	455
490	489	411	381
538	503	426	366
487	480	402	472
484	...	399	399
556	...	...	...
508	...	...	...
Av. 516	Av. 505	Av. 409	Av. 421

TABLE 3.—Results of tests of 9-inch beams in cantilever apparatus

Modulus of Rupture			
Series A, mix 1:2, age 14 days Lbs. per sq. in.	Series B, mix 1:3, age 28 days Lbs. per sq. in.	Series C, mix 1:3, age 7 days Lbs. per sq. in.	Series D, mix 1:3, age 7 days Lbs. per sq. in.
518	507	389	393
538	545	389	447
541	515	459	441
562	442	405	435
577	539	384	447
550	549	406	396
616	518	363	453
496	503	363	411
595	474	450	429
570	...	420	444
Av. 553	Av. 510	Av. 403	Av. 430

TABLE 4.—Average results of tests of each series and mean deviation from average

Series	Center loading		Cantilever, 12-inch beams		Cantilever, 9-inch beams	
	Average modulus of rupture	Mean deviation from average	Average modulus of rupture	Mean deviation from average	Average modulus of rupture	Mean deviation from average
	Lbs. per sq. in.	Per cent	Lbs. per sq. in.	Per cent	Lbs. per sq. in.	Per cent
A.....	543	5.2	516	5.2	553	4.7
B.....	511	3.5	505	3.4	510	5.0
C.....	413	6.1	409	4.6	403	6.2
D.....	417	5.0	421	6.2	430	4.2
Mean.....	...	5.0	...	4.8	...	5.0

Tables I to 3 give the breaking load and computed moduli of rupture for each individual specimen. Table 4 presents a summation of the strengths, together with the mean variation from the average for each series.

There appears to be little variation between the test results obtained by the two methods of testing. The strengths obtained are essentially the same and the variation found between individual breaks averages the same in each case. It may be said that the testing of mortar beams can be performed as accurately with this cantilever device as by the customary method in the universal machine.

The retests of the 18-inch beams are of interest since they demonstrate that specimens broken under center loading may be checked by tests of the two halves in the cantilever apparatus. In a series of tests extending over several periods of testing, one 18-inch beam could be tested at three different ages, the first test being by the center loading method, and the other two by cantilever action. Such a method would furnish a more accurate index of the effect of age than could be obtained with three different specimens with the accompanying uncertainty of identical preparation.

Working drawings of the cantilever apparatus may be obtained upon request to Bureau of Public Works.

Rapid Road Improvement

Wisconsin highway engineers established early in last June what is believed to be a new record for opening concrete pavement to traffic. When it was learned that President Coolidge would spend his summer vacation at Brule, Wisconsin, W. C. Buetow, chief highway engineer of Wisconsin, decided to put into good condition the highways between Brule and Superior in the shortest possible time. Concrete pavement had already been carried part of the way but an unpaved strip of road near Amnicon Falls was in bad condition. At 9 o'clock in the eve-

ning of June 4 instructions were given to lay this pavement, using high-early-strength concrete. By seven the next morning the state engineers had staked out the project and the forms were set by noon. At 9 o'clock that night the last of the concrete had been placed and the next afternoon at 5, just 44 hours after the work had been ordered, the road was opened to traffic.

Laboratory tests are said to have shown the concrete to have a compressive strength of over 2000 pounds per square inch in 20 hours. The work was done by A. N. Nelson, contractor, of Duluth.

Jacking Culverts Thru Clay and Rock*

Three culvert replacements were completed at a saving of half of the estimated cost of trenching and without interrupting traffic.

By A. W. Paine†

About fourteen miles south of Parkersburg, W. Va., on the Parkersburg-Charleston road three failures were observed last summer in the concrete pavement. The cause was found to be the settling away of the fill through openings in sectional pipe culverts which had collapsed or disjointed. Immediate replacement of the culverts was seen to be necessary.

Maintaining this busy road open to traffic was essential, yet no suitable detour was available. Trenching through the fill would be expensive in the first place and would leave a place difficult to maintain afterwards. In addition it could hardly be carried out without traffic interruption. It was decided, therefore, to take advantage of the Armco jacking method whereby the new culverts could be installed without disturbing either traffic or roadway.

The scheme finally adopted called for installing two of the new culverts at the same location as the old ones, removing the old pipe fragment by fragment as jacking proceeded. Although a smaller culvert would have carried the water in each case, a 24-inch pipe was used. This size has barely enough room for a man to work inside after a fashion. Armco corrugated pipe in 20-foot sections was used.

The pipe was supplied with the ends punched for riveting the joints, and with the side seam in the last two feet of each section left unriveted, enabling it to be spread and slipped over the next joint. Cold rivets were supplied. For the third culvert, 36-inch pipe having similar provisions was used.

The equipment and materials used for jacking the two 24-inch culverts included:

Ratchet screw jack, 75-ton
Small mattock with short handle for digging inside of pipe
Small shovel, like trench shovel
Short crow bar
Wrecking bar, 24-inch

*From "The Highway Magazine."

†Division maintenance engineer, W. Virginia State Road Commission, Parkersburg.

Single snatch block with hook (to fasten to top of pipe at front end)

Wooden sled, 15 by 24 by 6 inches deep

Lining timber, 8 by 14 inches by 24 feet

Post, 8 by 9 inches by 9 feet, for backstop

Brace for post, 8 by 9 inches by 14 feet

Block to support jack, 12 by 12

Blocking, several pieces 6 by 6, two to eight feet long, to transmit jack pressure.

Square portal frame of 3 by 6-inch timbers with 3 by 6 cross piece to jack against

120 feet of $\frac{1}{2}$ -inch rope

All of the above equipment was used also for jacking the 36-inch pipe. The wooden sled was improved for the latter installation by placing it on casters and providing a plank runway in the bottom of the pipe. In addition, the following power equipment was added to provide for the unforeseen material encountered and to speed up the work:

90-cu. ft. belt-driven Novo compressor with a Ford generator attached

Jack hammer with short lengths of $\frac{7}{8}$ -inch drill

Steel chipping hammer with necessary steel bits

6-volt battery and 6-volt light bulbs, connected with good grade of insulated wire

The Ford generator, with a small friction wheel, was so attached to the compressor that it operated on the pulley of the compressor unit and supplied lights for the workmen inside the pipe.

The Armco jacking method, as most engineers now know, consists essentially of forcing corrugated pipe underground or through an embankment by means of one or more horizontal jacks braced against a suitable backstop. The pipe does not cut its way, but follows as a shield, men excavating a short distance ahead and hauling the spoil out through the pipe.

The first step was to excavate into the slope of the fill to provide a face four or five feet high to work against and a trench along which to jack the pipe. The line of each culvert was staked out with a transit and sighting stakes were set on the lower side to aid in locating the pipe when jacking was started. Levels were run, an accurate cross-section obtained, and grades were set.

The next step was to locate the lining timber accurately and nail 2 by 4 strips on either side to guide the pipe while being jacked. Care in guiding the first section proved warranted, as each line of pipe came out at the upper end with but little deviation from the computed location.

On each of the jobs, jacking was started from the lower side. Jacking uphill had the advantage of permitting the excavated material to be removed by gravity and, in one case, of preventing the pipe from being flooded during a rain.

The backstop post was firmly set and braced, the jack, portal frame and blocking put in position, and the first section of pipe rolled on the lining trough. The face of the fill was then undercut from one to two feet and jacking begun. Only one man could work inside the 24-inch pipe. With the tools mentioned above he excavated just ahead of the pipe and placed the material in the sled. Men outside pulled the sled out by the rope, and by means of the snatch block attached to the inner end of the pipe, pulled it back in again.

Sufficient light and air were available from the old culverts so the man inside had no difficulty in working. Two men alternated working inside the

pipe, having to change off frequently due to the cramped position in which they worked. The broken tile had been pressed so tightly into the embankment that its removal probably took at least as much time as would have been required for the removal of a full face of earth.

The excavation was carried to exact grade at the bottom of the pipe, but clearances of 1 inch at the sides, and 2 inches at the top, were provided to prevent the pipe from becoming squeezed. The limits of excavation were carefully checked, to avoid running off of line during jacking. Troughs 6 inches wide and same depth were dug at 3-foot intervals below the bottom of the pipe to catch loose material dragged forward by the corrugations.

One of the 24-inch lines started to dip after it had been jacked about 30 feet, and to correct this tendency a wedge shaped board was placed under the front end of the pipe while jacking. This board was removed without difficulty and moved forward, at each resetting of the jack and answered its purpose satisfactorily.

Rainy weather was encountered while jacking the 36-inch pipe and a canopy was erected to protect the men working inside. The canopy extended from the face of the cut out over the jack.

Work on the three culverts was started September 20 and completed October 10. Because of the lateness of the season, work was continued night and day on the 36-inch pipe. Only daylight shifts were worked on the 24-inch culverts.

After advancing about 10 feet with the 36-inch pipe, an 18-inch face of solid rock was encountered and then the air compressor was started. Part of the rock was soft enough to be broken with the chipping hammer; but the remainder had to be drilled and shot. Two men worked inside, as one man could not operate the drill successfully. After each shot, compressed air was used to clear out the fumes. The air hose was used also while the men were inside digging, to renew the air which otherwise became hot and foul.

The success and safety with which blasting was accomplished was gratifying because it established the jacking method as a useful means of installing pipe through almost any kind of solid material. Picric acid was used instead of dynamite. There might have been some damaging effects from using dynamite, as it is probably a little faster than picric acid. Too, noxious fumes of dynamite would be harder to remove in a reasonable length of time, even with the air hose. Picric acid comes in one-pound sticks, and from one-half to one-quarter stick was used in each hole.

For each shot two holes were drilled into the rock about 18 inches, parallel to a vertical plane through the center line of the pipe and sloping down at an angle of between 15 and 18 degrees. At the same time the clay was removed by hand from over the rocks. The holes were charged and the acid detonated by means of the 6-volt battery. From two to three sets of holes had to be shot in this fashion in order to remove the rock and permit jacking, as the holes had to be loaded very lightly.

No damage was done to the pipe or the fill by the shooting.

The total cost of the three jobs was \$631, or approximately 44 per cent of the \$1,457 estimated as the cost of trenching through. The cost of installing included labor, rental of the compressor and air hammers, and gas, oil, and other supplies, as well as the pipe itself. The trenching estimate did not include the costly item of replacing the pavement and maintaining the resulting bad spot, nor the cost of maintaining a detour. The money and time saved on the job by the Armco jacking method have always proved substantial. But to the highway user the avoidance of detours often saves an equal or greater

amount and is an advantage which is most apparent and most appreciated.

COMPARATIVE DATA, THREE JOBS

	Culvert No. 1	Culvert No. 2	Culvert No. 3
Diameter	24 inches	24 inches	36 inches
Length jacked.....	60 feet	60 feet	60 feet
Total length.....	72 feet	60 feet	74 feet
Material encountered..	Clay	Clay	Clay and Rock
Ave. depth of fill....	12 feet	14 feet	20 feet
Days to install.....	6	4	10 (double shift)
No. men used.....	4	3	4 each shift
Estimated cost by open trench	\$316.00	\$352.00	\$789.00
Total cost by jacking	\$130.00	\$ 66.00	\$435.00
Estimated saving.....	\$186.00	\$286.00	\$354.00



SNOW FIGHTING IN CITY AND COUNTRY

Left Side: Top—Rotary plow clearing road to summit of Pikes Peak. Middle—Clearing Montreal Streets with "bulldozers." (Note snow fences.) Bottom—La Plant-Choate hydraulic back-filler and snow plow in Villa Park, Ill. Middle: Top—Cutting road through snow five to seven feet deep in Donner Pass, Sierra Nevada, using combination push and rotary plow. Bottom—Removing 8 inches in Portland, Ore., using a Killefer plow. Right Side: Top—Clearing road near Winnipeg with a Wausau Junior V plow. Middle—New England sidewalk plow. Bottom—Russell No. 4 Patrol in Peoria, Ill. All above are operated by "Caterpillars." We are indebted to the Caterpillar Tractor Co. for the photographs.

Keeping Colorado Highways Open

The following statement, published in the July issue of "Colorado Highways" (official publication of the state highway department) tells clearly, in cold figures, what a real problem the snow on the mountain roads presents to the highway department of Colorado. Bucking twenty-foot drifts in June and using dynamite to break the ice crust on the road makes pleasant reading in Texas in August.

"The battle with snow on roads in Colorado has ended. June 15 saw all high passes in the state opened to traffic. The work of clearing the mountain passes of snow started in May, when the state highway department put its big rotary plow in operation on Berthoud Pass. This main artery of travel running west from Denver into Middle Park, was opened the earliest in history, notwithstanding the fact there was deeper snow on the pass this year than in previous years.

"On June 1, automobiles started moving over the pass. This was ten days earlier than in former years. The early opening of the pass was made possible by the use of the mammoth rotary plow owned by the state highway department. Last fall the plow was mounted on a heavy-duty Coleman four-wheel truck, and the plow made into one unit. Two motors are now used, one to drive the wheel of the plow exclusively, while the other furnishes power for the truck.

"Snowslides and drifts measuring twenty feet in depth were encountered by the plow, and long stretches of snow and ice ten to fifteen feet deep were moved from the roadbed. With the rotary plow it was possible to throw this snow clear of the road. In places the snow had melted and then frozen into almost solid ice. Dynamite was used to break this up. Two maintenance crews were employed on the work, with ten men in each crew. One crew worked from the bottom of the east slope, while the other started at West Portal and worked to the top from the west. The altitude at the summit of the pass is 11,315 feet.

"In charge of the work on this pass were: Robt. H. Higgins, state maintenance superintendent, and John Stamm, assistant, with John Sharp and Frank McQueary, foremen. The plow used in the work was constructed in the state highway shops.

"While the work on Berthoud was progressing, other state crews were busy in other parts of the state in clearing snow from the high passes, getting them open for the tourist season, which starts early in June. In almost all cases it was necessary to furrow huge cuts through the snow. It is a gigantic task, and few motorists realize the tremendous amount of work that is required.

"Perhaps a better understanding of the work of opening these mountain roads is to cite the elevation above sea level of the more important passes. To refresh the memory, a mile is 5,280 feet, and the elevations of these passes are: Berthoud, 11,315 feet; Fall River, 11,797; Rabbit Ear, 9,680; Willow

Creek, 9,683; Muddy, 8,772; Cameron, 10,285; Fremont, 11,320; Independence, 12,095; Monarch, 11,650; Red Mountain, 11,018; Wolf Creek, 10,850; Cumbres, 10,003; Tennessee, 10,276; Hoosier, 11,542; Milner, 10,759; Cochetopa, 10,032.

"For the first time an effort was made to keep Tennessee Pass open last winter. Success marked this undertaking. With the exception of a few days after storms, traffic moved over this pass throughout the winter months. Two tractor and blade outfits were employed in this work. These outfits operated over a distance of about sixty miles, from Granite to Eagle. The equipment included two 10-ton Caterpillar tractors and two 12-foot graders, a Big Buster and a Rip Snorter. Also, there was a crew operating a one-man maintainer on the Eagle end of the work. Eagle county furnished the one Holt tractor, the Rip Snorter and maintainer.

"The crews worked all winter in snow from 4 to 10 feet deep. A two-way road was maintained over Battle Mountain. Four and five feet of snow were encountered on this spectacular stretch of roadway. George Toupain, assistant maintenance superintendent, had supervision of this work, with Frank McQueary, foreman, in charge.

"Tractors with push-plows were used in clearing the snow from Molas Pass, located between Durango and Silverton, and also in the removal work done on Red Mountain Pass, between the latter town and Ouray, on the world-famous "million-dollar highway." D. Kirk Shaw, assistant superintendent in the Durango district, was in charge of this work. Crews operated from both the Durango and Silverton ends, using state and county equipment in the work. San Juan and La Plata Counties contributed the equipment.

"Similar operations were carried out on Monarch, Cumbres, La Veta and Wolf Creek passes. Several of the men employed on the crews were temporarily blinded in this work. Blistered faces and hands also were a common occurrence. Shovel crews are still employed in the clearing of the roads of rock slides.

"Men and equipment from Routt county opened the Gore Pass road. This road was opened to travel the middle of May. Rabbit Ear Pass was opened on June 8. Volunteers from Steamboat Springs aided in this work, using shovels to hasten the clearing of the road on the summit. Lloyd Gregg and Lou Watson are operating the state highway patrol over this pass from the Grand county side, and Andy Shupp and John Giggey are working from the Routt county side.

"The road over Monarch Pass was opened on June 8. John Jay, in charge of a crew, started work on the pass May 30, but was delayed on account of high water in the river, which threatened several bridges. Last year Monarch Pass was reported open on June 9, but, according to snow charts this year, there was at least twice as much snow in 1928 as in 1927.

"Traffic started moving over Fall River and Milner passes on June 15, the date of the formal opening of the Rocky Mountain national park season. The steam shovel crew cut through snow 26 feet deep. A hand crew of twenty-five men cleared the snow from the west slope of Milner, the steam

shovel being employed near the summit on the east slope of the pass. Roger W. Toll, superintendent of the Rocky Mountain national park, was in charge of this work.

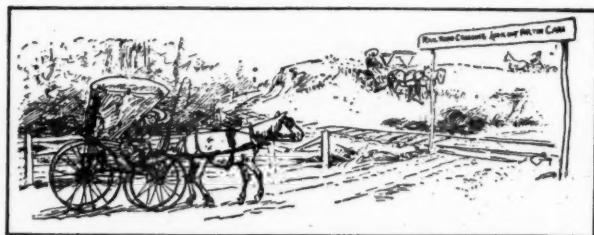
"Reports reaching the highway department state that the pass roads were never in better condition at this time of the year. Major L. D. Blauvelt, state highway engineer, has issued orders that these important arteries of travel be put in first-class condition, and every effort be exerted by the state maintenance forces to keep them smooth for the heavy summer motor traffic."

Unprotected Grade Crossings Increase

A study of grade crossing accident statistics in preparation for the work to be done by the Grade Crossings Committee of the County Officials Division, has just been completed by the American Road Builders' Association in cooperation with the Interstate Commerce Commission.

It was found that 206,533 unprotected grade crossings existed on class 1 steam railroads alone at the beginning of 1927, while the number of protected crossings totaled only 27,747. Of the protected crossings, 6,148 were guarded by gates, 7,760 by watchmen, 6,427 by audible and visible signals, 5,308 by audible signal only, and 2,204 by visible signal only.

During 1927 the persons killed at grade crossings totaled 2,371 and the injured 6,613. No reports of accidents or the number of unprotected grade crossings on electric or oil railroads was available, although the association hopes to have such report available within a short time.



From "Colorado Highways."

A "VISIBLE SIGNAL" IN 1900

The accompanying table shows the number of unprotected grade crossing in each of the states and the number of casualties occurring in each:

Number of Unprotected Grade Crossings and Casualties in 1927 in Each of the States

State	Total deaths	Total injuries	Unprotected crossings
Alabama	34	143	4,125
Arizona	9	28	958
Arkansas	23	91	4,251
California	118	330	6,254
Colorado	24	48	2,766
Connecticut	10	23	461
Delaware	7	29	251
Florida	34	125	4,682
Georgia	36	137	5,080
Idaho	9	16	1,838
Illinois	205	567	2,376
Indiana	188	431	7,977
Iowa	35	148	1,035
Kansas	55	241	1,386
Kentucky	48	119	2,883
Louisiana	41	84	3,161

Maine	11	13	905
Maryland	20	38	815
Massachusetts	22	55	708
Michigan	118	388	8,261
Minnesota	35	101	8,117
Mississippi	52	123	2,783
Missouri	44	142	7,242
Montana	4	33	2,268
Nebraska	23	56	6,657
Nevada	2	5	432
New Hampshire	12	21	702
New Jersey	89	206	1,667
New Mexico	9	19	940
New York	193	452	5,024
North Carolina	33	113	4,687
North Dakota	10	32	5,629
Ohio	300	619	9,673
Oklahoma	41	141	7,285
Oregon	16	29	1,723
Pennsylvania	139	434	8,425
Rhode Island	1	6	58
South Carolina	11	69	3,544
South Dakota	13	23	4,626
Tennessee	43	122	3,958
Texas	86	350	11,771
Utah	4	24	1,491
Vermont	10	33	468
Virginia	49	71	3,518
Washington	20	73	3,596
West Virginia	22	55	2,196
Wisconsin	63	206	7,075
Wyoming	..	1	588
District of Columbia	..	..	22
Total	2,371	6,613	206,533

Actual Cost of Grading

The following from "Public Construction News" illustrates why some contractors, who neglect to allow in their bidding for overhead, depreciation, insurance and incidentals, "go broke."

"Experience of old grading firms related to us in confidence indicate the narrow margin between profit and loss on most of our present day work. In our possession is a record of grading work on a small section in central Illinois. This work was on a paving contract done with a well equipped elevating grader outfit. Grading quantities were quite small, not more than 3,500 cu. yds. per mile. The tabulated cost records may be interesting.

Contract, 16,500 cu. yds. excavation at 39 cents \$6,435.00

EXPENSE

Superintendence	\$ 206.25
Labor pay roll	3,100.93
Camp overhead	206.70
Moving	48.60
Feed for teams	511.16
Oil, gas and lubricants	371.52
Repairs	502.76
Bonds, insurance, incidentals, etc.	992.07
General overhead and depreciation	705.50

6,645.49

Loss \$ 210.49

"In our opinion this is a good example of grading costs showing the large expenses incurred for upkeep and operation of equipment. We are convinced that any reliable resident engineer would have reported this a profitable contract because records for items other than superintendence and labor were not readily available."

In this case labor and superintendence amounted to less than half the total cost; while bonds, insurance, general overhead, and depreciation totaled more than 25 percent.

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CONTENTS

RECENT DEVELOPMENTS IN SNOW REMOVAL. Illustrated. By V. R. Buston.....	291
Road Construction in 1928.....	295
SNOW HANDLING IN ONONDAGA COUNTY. Illustrated. By R. B. Traver.....	295
FIGHTING SNOW IN ALBANY. Illustrated. By Lester W. Herzog.....	296
Second Pan-American Road Congress.....	299
Improving Poor Subgrade.....	299
SERVICE PIPE IN WASHINGTON SUBURBAN SANITARY DISTRICT	300
Charleston Water Works Notes.....	301
WATER SOFTENING AT HINSDALE.....	301
NEW WATER SUPPLY FOR ATHENS, GREECE. Illustrated	302
Swimming Pool Sanitation in Baltimore.....	305
NEW SEWAGE DISPOSAL PLANT FOR DURHAM, N. C. Illustrated. By Preson P. Phillips...	306
Sewage Treatment at Columbus.....	309
SEWAGE TREATMENT ABROAD. Illustrated. By Willem Rudolfs.....	310
Texas Sewage Research Laboratory.....	312
Kansas Sewerage and Water Supply.....	312
MAINTAINING BALTIMORE'S SEWERS. Illustrated. By Milton J. Ruark.....	312
Garbage Disposal in Albany.....	314
Syracuse Garbage Reduction Plant.....	315
IMPERVIOUSNESS AND RUN-OFF TO SEWERS. Illustrated	315
CANTILEVER TESTING APPARATUS FOR MORTAR BEAMS. Illustrated.....	316
Rapid Road Improvement.....	318
JACKING CULVERTS THROUGH CLAY AND ROCK. By A. W. Paine.....	318
SNOW FIGHTING IN CITY AND COUNTRY. Illustrated	320
KEEPING COLORADO HIGHWAYS OPEN.....	321
Unprotected Grade Crossings Increase. Illustrated....	322
Actual Cost of Grading.....	322
EDITORIAL NOTES	323
An August Snow Number—Some Snow Removal Figures.	
SNOW REMOVAL IN KENOSHA, WIS. By P. J. Hurtgen	324
Federal Aid for the Next Three Years.....	325
SNOW REMOVAL IN PENNSYLVANIA. Illustrated. By W. A. Van Duzer.....	326
Duquesne Water Works Notes.....	329
Water Diviners in England.....	329
Albany's Air Port.....	329
Road Construction in Saxony.....	329
County Highway Equipment in Colorado.....	329
ACTIVATED SLUDGE PLANT AT BEDDINGTON, ENGLAND	330
Sewage Treatment Results at Holland, Michigan.....	330
THE DOWNES DIGESTION TANK. Illustrated..	331
RECENT LEGAL DECISIONS.....	332

An August Snow Number

Perhaps some may think it unseasonable and untimely to devote considerable space in an August issue to the subject of fighting snow on streets and highways. But, hot as it is today, snow is less than four months away in our northern states. And four months is none too long a time to prepare for it.

Twenty-five years ago, even ten years ago, there was little need for such a long preparation period. Then snow fighting was confined to cities, and was mainly a matter of hand shoveling and removing in wagons and trucks, both men and trucks being hired for the emergency from the abundance generally idle during the winter. And preparation consisted in contracting for the work with local contractors; or in assigning districts to foremen regularly employed by the city and instructing them in their duties, and arranging with owners of trucks for the hiring of same when needed.

But now the problem has entirely changed. Not a few miles in the business centers of large cities, but tens of thousands of miles of country highways as well as most of the city streets are kept clear of snow and practicable for use by twenty-five million automobiles. To do this by hand labor is out of the question—sufficient men are not available and the cost would be enormous. Motor vehicles are responsible for the demand, and motor vehicles have furnished the solution of the problem put up to the highway officials. Snow plows operated by motor trucks or tractors or self-operated, large motor trucks, snow loaders of various types, are used by the thousand.

Also, it is beginning to be appreciated that "prevention is better than cure" in the matter of snow drifts, and snow fences and windbreaks are being used along hundreds of miles of road; while in planning highway grades, thought is given to the advantage of a fill from which the snow will be blown, as compared with a cut in which it will collect.

Snow fighting is an emergency matter. It is recognized that it should be begun as soon as two or three inches have fallen. All the machinery needed must be at hand and ready for action before the first snowfall.

Such preparation takes time. Those responsible must familiarize themselves with the methods found successful by others and the equipment available for carrying them out; must investigate new equipment offered and, if it shows promise, purchase one or more for testing out. They must take stock of equipment on hand and have it put in good, substantial shape—no makeshift repairs that will break down when bucking a drift some stormy night, far from the shops or anywhere else. The roads to be included in the snow-fighting program must be decided upon, the amount of equipment needed must be estimated, and the amount of funds necessary for purchasing the additional equipment obtained. The first often depends upon the last—upon how much expenditure the tax-payers will stand for. And officials are coming to realize that they will

stand for almost any amount so long as they are convinced that it is used wisely and honestly in keeping the streets and highways open for traffic.

In making up the program, selecting the equipment and obtaining the appropriation, weeks will be consumed, and there still remains the obtaining of the equipment. From the first frosts of October until the drifts of mid-winter delay freight traffic, manufacturers of snow-fighting equipment—some of it, at least—will be swamped with orders and those late in reaching them may not be filled until the "worst storm of the winter" has come and gone. September is none too early to get in the order.

With the equipment on hand, there remains fitting it to the trucks or tractors which are to operate it, in the case of plows; or testing it out and familiarizing the men with its operation, in the case of rotary or other self-operated plows or snow loaders. Snow fences can be set as soon as the farmers have finished getting in their crops and the men for setting them are available. (It is sometimes policy to employ the farmers themselves for this work.)

The fortunate superintendent who has all these preparations completed can await the advent of winter, not only unworried but anxious for the opportunity to show what a fight he can put up against the worst that winter can do.

It is the purpose of the articles in this issue to encourage prompt attention to this subject and to aid officials in obtaining immediate appropriations for equipment; while both articles and advertising pages offer suggestions for the kinds of equipment that will best meet the individual needs presented by mountains and plains, city and country, wide boulevards and narrow roads.

Some Snow Removal Figures

The importance that snow removal has assumed in the field of highway maintenance is illustrated by some figures given below. We do not vouch for the accuracy of these. They have been gleaned from several sources, some official federal and state reports, some unofficial; but we believe that they are fairly accurate.

There are thirty-six states in which snow is a regular winter event. In these states are found 75 percent of the population of the country and more than 53 percent of the improved roads, 869,390 miles of which carry U. S. mails, while 585,000 pupils were carried over them by 32,000 motor buses to community schools last winter.

Nine states include their entire state system of highways in their snow removal programs. Last winter's program in the thirty-six states totaled 117,109 miles, while five years previous it had been only 27,096 miles. The cost last winter was about five million dollars as against \$762,159 five years before. The average cost per mile was about \$45 as compared with \$28 in 1922-'23. The increased cost is largely caused by the better service given—clearing the entire width of roadway and shoulders instead of a narrow lane, and keeping it clear instead of turning out only when drifts render it impassable.

The highways cost nearly seven billion dollars to build. The automobiles owned in the snow states cost nearly fifteen billion dollars. The amount spent in snow removal last winter was less than one-tenth of one percent of the cost of the roads; it was approximately one percent of the amount spent for gasoline by the 14,700,000 cars in the snow states; or about as much as was collected as gasoline tax during one winter month.

Do the tax-payers want snow removal? Stop it and see!

Snow Removal in Kenosha, Wisconsin

By P. J. Hurtgen*

The City of Kenosha has a land area of 4,576 acres, a population of 58,250, and has 141 miles of streets, of which 80 miles are paved with a permanent type of pavement.

No attempt is made to remove snow from our streets except in the commercial districts and the principal street intersections of the city. Our city has three distinct commercial districts known as the down town, north side, and west side areas, and from these districts we remove the snow entirely, or to such an extent as to cause a minimum of inconvenience to the traveling public.

Our practice is to plow and scrape snow into windrows in the gutters on each side of the street and from that point load it onto trucks by either hand or machinery, or both, depending on the amount of snow necessary to be removed.

While no snow is hauled away in residence sections, we do, however, when necessary, plow these streets by working the snow to the sides of the streets.

We operate eight V-shaped wooden plows drawn by one horse for removing snow from sidewalks, also one broom sweeper for sidewalk work. These are operated principally to clear sidewalks leading to the schools for the accommodation of the school children. The property owners as a rule take care of their walks. However, should the property owner fail to remove the snow from the walks in front of his premises, the Wisconsin law authorizes the city to remove it and charge it against the property and enter the charge on the tax bill.

A rotary broom mounted on a Fordson tractor is used to clear the snow from the park walks and in front of city property and works very successfully in snow up to 8 inches in depth. Along the street railway lines, the utility uses a blade plow attached to the front end of a utility car and pushes the snow in windrows to the sides, and where deemed necessary the snow is removed by both the city and the street railway corporation.

Windrowing by the city forces is done with ordinary blade plows mounted on the front end of 2½-ton trucks, and one mounted on a 4-ton crawler-type tractor. We also operate two Wehr-type grad-

*Director of Public Works, Kenosha, Wis.

ers mounted on Fordson tractors with the blade attached between rear and front wheels of tractor. The latter units work successfully in snow not exceeding one foot in depth. After the snow has been windrowed in the above manner, it is ready for hauling to the dump or sewer.

Last year we purchased what was commonly known as a Lessmann loader* with a $\frac{1}{4}$ -yard bucket for loading earth, mounted on a Fordson tractor with crawler tracks. This unit works very well and economically in handling earth, filling trenches, and leveling earth and rubbish on our dumps. We also bought a half-yard basket with a view to using it for snow removal, and as we did not have much snow last winter, it filled our needs very satisfactorily and should give good service for the smaller cities which cannot afford large, expensive snow removal units. For large cities, however, the conveyor type of snow loader, with its greater capacity would, I feel certain, be more economical.

After heavy snow falls and on short hauls, we have used horse-drawn $\frac{3}{4}$ -yard wheel scrapers and dumped the snow into the sewers where sewers were large enough to carry off the snow. The dumping was done through manholes at street intersections and in the middle of the blocks.

Our snow hauling equipment consists of fifteen $1\frac{1}{2}$ to 3 yard trucks, and in case of severe storms, we also use our $3\frac{1}{2}$ -yard garbage trailers. Our hauls are usually less than 5 blocks. In our down town section, we dump the snow in the lake. In the north side section, we dump into the river, and the snow from the west side is hauled on the vacant lots.

There has recently been developed a blade snow plow, known as the Gettelman plow, that works very efficiently in that the snow rolls and slides along the blade and requires considerably less power to operate than most snow plows now on the market. This plow is so shaped that it acts on the same principal as does the mold board on an ordinary field plow by turning and rolling the snow rather than pushing it as many of the snow plows do.

With the change of the motor car to a commercial vehicle, it has placed upon all cities the responsibility of maintaining the thoroughfares in such condition that vehicles can operate with reasonable ease and speed during all seasons of the year, including the winter months. This has made it necessary for cities to provide sufficient equipment for snow removal to meet these conditions. So rapid has been the change in the mode of transportation that not all cities have been financially able to meet it by providing the necessarily expensive equipment required for prompt and efficient snow removal.

The public demand for high class service is constantly increasing and this can be provided only by increasing the city budget and providing an efficient organization to carry on the work. Transportation companies, both street railway and bus lines, should co-operate by doing their share toward keeping the thoroughfares open for traffic by assisting in snow removal work.

Just how to accomplish this is a matter that each

municipality must work out for itself, as it depends largely on the intensiveness of the service and the equipment and organization available to give that service. From observations I have made I am convinced that the best method of snow removal for large cities in the snow area is to employ plows to work the snow to the sides of the streets, and then, with one of the belt or chain conveyor type of machines, convey the snow into 4-ton to 6-ton trucks and dispose of the snow at the nearest dump. That dump may be the river, lake, sewer, or vacant lot. The type of equipment necessary to pull or push the plows will vary with the depth and compactness of the snow. Up to 15 inches, 2-ton to 4-ton tractors or trucks will handle the situation. For greater depths, up to two or more feet, 10-ton tractors may be advisable. For small cities, some mechanical type of loader such as we employed last year will operate quite satisfactorily, using such capacity trucks as are available in the city departments. The use of steam shovels may be employed where wet snow has become solidified by freezing, but from observations, I am convinced that, because of their unwieldiness, they should not be purchased especially for snow removal work. However, if a city is fortunate enough to have a steam shovel for excavation work, it might be profitably used for snow removal in lieu of hand shoveling.

Federal Aid for the Next Three Years

The allocation of Federal funds for 1929, 1930 and 1931 road construction in the United States and Hawaii has been made by the United States Bureau of Public Roads. There may be a few minor corrections in the apportionments for 1930 and 1931 as a result of mileage revisions. With the exception of thirteen states in which more than 5 percent of all land is non-taxable, the states must finance at least 50 percent of Federal Aid road costs and in no case will the government contribute in excess of \$15,000 per mile.

The apportionment to each state and Hawaii, and the minimum which may be expended on the same roads by the states, for each of the years 1929, 1930, 1931, are as shown in the accompanying table.

There are still more than two million miles of unimproved roads in the country, many of which carry traffic warranting improvement. At \$30,000 a mile these would cost sixty billion dollars, or nearly one hundred times as much as was spent for road construction last year. Highway contractors need not fear working themselves out of a job for many years yet.

State	Federal Apportionment	Minimum State Share
Alabama	\$1,547,483	\$1,547,483
Arizona	1,059,081	404,951
Arkansas	1,281,785	1,281,785
California	2,486,415	1,893,659
Colorado	1,383,401	1,083,484
Connecticut	474,213	474,213
Delaware	365,625	365,625
Florida	901,311	901,311
Georgia	1,980,015	1,980,015
Hawaii	365,625	365,625
Idaho	932,962	628,481
Illinois	3,135,225	3,135,225
Indiana	1,921,463	1,921,463
Iowa	2,035,291	2,035,291

*This has been taken over by the Trackson Company and is now known as the Trackson loader.

Kansas	2,062,196	2,062,196	Ohio	2,757,964	2,757,694
Kentucky	1,421,029	1,421,029	Oklahoma	1,749,066	1,405,815
Louisiana	1,019,282	1,019,282	Oregon	1,189,707	1,404,109
Maine	681,431	681,431	Pennsylvania	3,333,786	3,333,786
Maryland	634,906	634,906	Rhode Island	365,625	365,625
Massachusetts	1,088,808	1,088,808	South Carolina	1,059,533	1,059,533
Michigan	2,209,596	2,209,596	South Dakota	1,223,981	976,632
Minnesota	2,112,595	2,112,595	Tennessee	1,612,012	1,612,012
Mississippi	1,309,729	1,309,729	Texas	4,502,576	4,502,576
Missouri	2,404,347	2,404,347	Utah	848,093	226,803
Montana	1,552,576	1,199,064	Vermont	365,625	365,625
Nebraska	1,584,981	1,584,981	Virginia	1,437,548	1,437,548
Nevada	957,995	134,115	Washington	1,143,226	962,152
New Hampshire	365,625	365,625	West Virginia	793,796	793,796
New Jersey	935,122	935,122	Wisconsin	1,864,212	1,864,212
New Mexico	1,189,361	685,715	Wyoming	939,547	524,068
New York	3,629,879	3,629,879			
North Carolina	1,715,910	1,715,910			
North Dakota	1,193,440	1,193,440	Totals	\$73,125,000	\$66,016,664

Snow Removal in Pennsylvania

All hard surface roads of state highway system kept open last winter—more than eight thousand miles at about one hundred dollars a mile. Use of snow fences. Organization and equipment needed. Costs for each of the past five winters.

By W. A. Van Duzer*

Snow removal has been a recognized state highway department function in Pennsylvania for ten years. It has come to be almost commonplace with the traveling public and a matter of routine with the department of highways. It is still true that occasionally a blizzard condition makes a section of road or a locality temporarily out of control, blocks roads and piles up snow in quantities that require a day or two for their removal; but generally speaking, the work of removal on the program mileage goes on simultaneously with the precipitation, the roadways are kept open for traffic, and shortly after the expiration of the storm the snow is moved back on the berms, drains are opened, and all without interruption to traffic.

During the 1927-28 winter all hard-surfaced mileage—8,413 miles—of the state highway system of Pennsylvania was kept free from snow. The total cost of this work was \$849,043.93. The average cost per mile of the snow removal was \$100.92, and, the average snow fall for the state having been 40.9 inches, the average cost per mile per inch of snow fall was \$2.47. The accompanying tabulation compares snow removal costs by years for the past five years. The costs shown are the snow removal program for the

winters 1923-24 to 1926-27, inclusive, and total costs for the 1927-28 winter; the explanation being that during the past winter, for the first time, virtually the entire hard-surfaced mileage of the state system was included in the snow removal program.

SNOW FENCES

To some extent the comparatively small amount of drifting during the past year has been due to the fact that the heavy precipitations have been of moist snow, and have not generally been accompanied by high winds. It is only fair, however, to credit the extensive installation of snow fence with accomplishing some of the reduction in drifting. There were 493,076 feet of standard snow fence purchased during the year 1927. (The standard snow fence used in Pennsylvania is shown in the accompanying illustration.) The 1927 purchases, together with previous purchases, made available 1,653,349 feet (about 300 miles) of snow fence, all of which was placed and in use during the past winter.

No permanent type of snow fence is in use, but the department has planted 12,600 evergreens, comprising about 15,750 feet of wind break.

The indications are only approximate, but they are that the expenditures for snow fence have

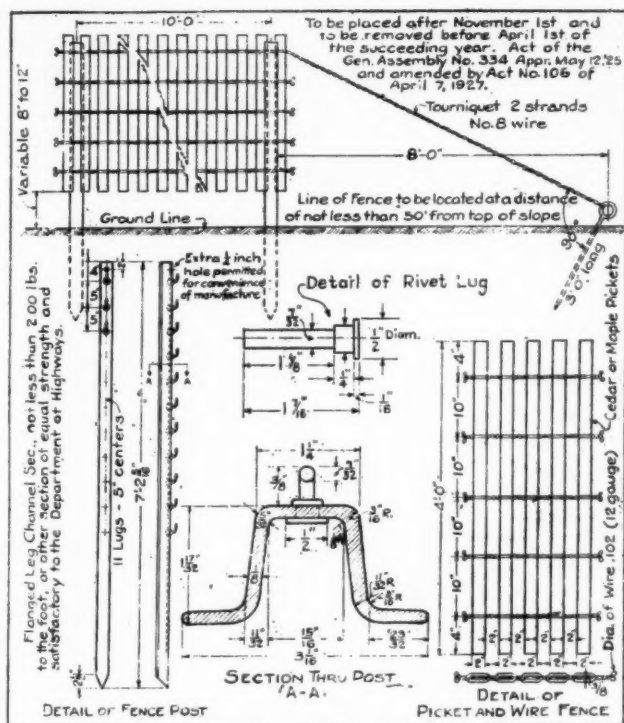


THE OLD WAY—BY HAND



USING A STRAIGHT-BLADE PLOW

*Assistant chief engineer, Pennsylvania Dept. of Highways.



PENNSYLVANIA STANDARD PICKET AND WIRE SNOW FENCE

reduced total costs to such an extent that increasing expenditures for spreading cinders on icy hills have not caused a net increase in the total unit cost.

ORGANIZATION FOR SNOW REMOVAL

The highway organization described in the July issue of PUBLIC WORKS is the basis upon which the work for snow removal is built. The state is divided into eight divisions, each in charge of a division engineer. Reporting to each division engineer are from five to eight maintenance superintendents, each in charge of a



TWO TYPES OF PLOW IN USE

county, or, in the case of small counties, in charge of two or more counties. In all there are 52 districts, and these districts are the units through which snow removal is accomplished.

There are buildings, located in the various maintenance districts, which house road-working and snow-fighting equipment. These buildings were described and illustrated on page 254 of PUBLIC WORKS for July, 1928. Offices are provided in these buildings, and during the

Snow Removal Costs for Each of the Past Five Winters

Item	1923-1924	1924-1925	1925-1926	1926-1927	1927-1928
<i>Costs on Program</i>					
Average snowfall in state (inches).....	48.0	43.0	50.4	35.0	40.9
Snow removal program mileage	2,902.0	4,251.0	5,061.0	6,361.0	8,413.0†
Program mileage x inches of snowfall.....	139,296.0	182,793.0	255,074.0	222,635.0	344,092.0
<i>Operations 91, 92 and 93—</i>					
Total cost on program (incl. 1 per cent)*.....	\$380,436.39	\$450,156.31	\$642,612.96	\$599,883.12	\$849,043.93
Average cost on program per program mile.....	106.28	105.89	126.97	94.31	100.92
Average cost on program per inch-mile of snowfall.	2.21	2.46	2.52	2.69	2.47
<i>Operation 92—</i>					
Cost of removal (hand and mech.) on program mileage (incl. 1 per cent)*	280,600.79	422,265.37	557,635.14	408,889.11	504,269.51
Average cost of removal (hand and mech.) per program mile	96.69	99.33	110.18	64.28	59.94
Average cost of removal (hand and mech.) per inch-mile of snowfall	2.01	2.31	2.18	1.84	1.47
<i>Operation 91—</i>					
Total cost of snow fence (incl. 1 per cent)*.....	27,835.60	27,890.94	58,088.18	120,037.57	169,488.55
Average cost of snow fence per program mile (incl. 1 per cent)	9.59	6.56	11.48	18.87	20.15
Average cost of snow fence per inch-mile of snowfall .....	.20	.15	.23	.54	.49
<i>Operation 93—</i>					
Total cost of spreading cinders (incl. 1 per cent)*.	.....	.....	26,889.64	83,764.47	175,285.87
Average cost of spreading cinders per program mile .....	.....	.....	5.31	13.17	20.84
Average cost of spreading cinders per inch-mile of snowfall .....	.....	.....	.11	.38	.51

*The one percent is added to cover cost of small tools. †Labor, materials and equipment rentals accounted to May 31, 1928.

winter months they are open 24 hours a day, with a watchman on duty at all times. When the weather conditions indicate snow, the watchman calls the maintenance superintendent, who orders out the men when, in his judgment this appears desirable. The men normally report at the beginning of the snowfall, and work is started when the snow is 2 inches deep.

The men are called by telephone. While on this work, they are fed by, or at the expense of, the state. Work, so far as possible, is continuous until snow removal is complete. Men are paid for overtime. Few extra men are ordinarily needed on this work, since mechanical equipment has largely replaced hand work. In all, there are about 2,000 regular men available for this work throughout the state.

In each district is stored and maintained the equipment normally employed or likely to be employed in snow removal work in the state. In addition, in each division there is held reserve equipment. This includes extra equipment to replace that disabled by accident in hard use, and also equipment which is not at all times needed, such as rotary plows and other heavy machinery.

EQUIPMENT IN USE

During the 1927-28 winter there were in use 595 truck plows, of which 186 were V-model without wings and 409 straight blade moldboard plows without wings; 95 tractor plows of displacement type, two with wings; 21 tractor plows of rotary type, and a Fox snow loader.

The trucks include Coleman, Walter, Nash, Quad (war equipment), F. W. D., Packard, Pierce-Arrow, White, Mack, International, G. M. C., and Autocar. The first four are 4-wheel drive, a type especially valuable for heavy work. Most of the others are 3-ton trucks equipped with straight blades, and are used for snow depths up to 24 inches. Because of their speed and mobility, they can reach the work in a short time and, when the snowfall is not too heavy, can clear a large mileage of roads.

For heavier snowfalls the V-type plow is used. These are used chiefly in connection with 5-ton Macks. For heavy drifts the tractor-driven ro-



SNOW LOADER CASTING SNOW OFF THE ROAD

tary plows are provided from the divisional reserve equipment.

Just outside of Philadelphia a 14-mile section of pavement 40 feet wide requires some special equipment. For this there is provided a Fox snow loader. After a V-plow has been driven through, the snow loader clears the roadways to the desired width, loading into trucks which drive alongside, or wasting snow over the banks, as it will throw the snow about 9 feet to the side. It is also valuable in other places where the snow must be removed, as in built-up areas.

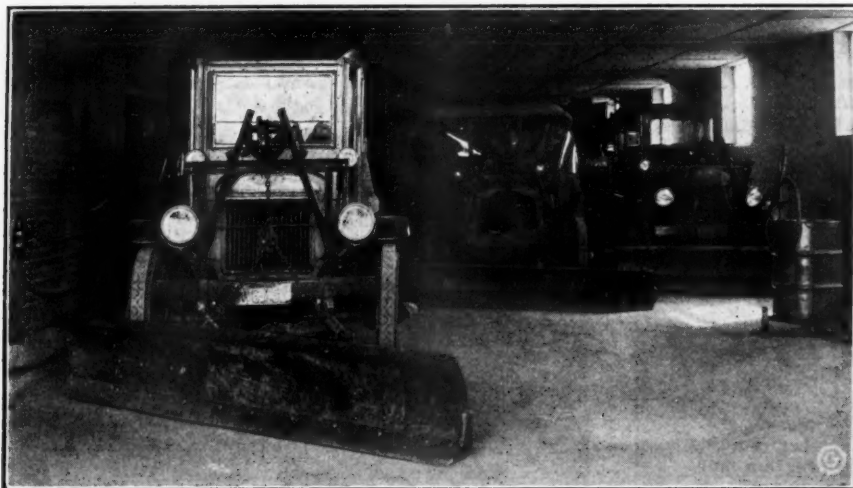
The average task assigned each 3-ton straight-blade truck and gang over a settled route on ordinary snowfalls is 12 to 15 miles.

The snow plows mainly used include Baker, Champion, Moul, Harrisburg Machine and Boiler, LaPlante-Choate, Seabrook-Sargent, Snow King, Russell and one built by the department.

A striking feature of the snow campaign of the past year has been the celerity with which the roads have been opened, indicating that the present snow equipment is much more effective than that of previous years. In the areas where there has been the heaviest snowfall, the roads have been under the maintenance of plows of the tractor rotary type.

The present standard of snow removal equipment recognizes the importance of a roomy and fairly comfortable enclosed cab and effective lights to enable the operators to keep going for long periods and to do efficient work during night storms.

This additional and improved equipment together with the increased installation of snow fence, and with operation more efficient due to the fact that the organization has been improved, have combined to bring the snow problem under better control.



SNOW REMOVAL EQUIPMENT IN DEAD STORAGE

Dubuque Water Works Notes

Dubuque, Iowa, purchased its water works from a private company in 1900 for \$545,000; the plant including 44 miles of mains, 340 fire hydrants, 540 gate valves and 1,854 taps. The annual report for the year ending March 31, 1928 shows 98 miles of mains, 698 fire hydrants, 1,665 valves, 8,249 meters, the services being 99.75% metered.

The city has been paying the water works department \$38.64 per hydrant per year or about \$26,000 annually; while in turn the department paid the city interest on the \$545,000 purchase price, making an annual expenditure of \$25,929. These amounts practically balance, but there was considerable confusion, many citizens being misled to believe that the water works actually gained \$26,000 by the transaction. Therefore it was decided to omit the hydrant rental and the interest charge starting April 1, 1928. The city had also charged the water works \$1,800 a year for office rent and the water works charged the city for \$1,800, for street and sewer flushing, but this transfer also has been omitted.

During the past year, 9,714 feet of 4" to 12" mains were laid. The average cost of a 6" main laid in ordinary excavation was \$1.42. This is considered very low, and was made possible by the fact that the market price of cast iron pipe was unusually low, and by the application of modern methods and practices by which the installation costs were brought down to a minimum. For instance, by using centrifugally cast pipe and leadite joints a saving of 18c. a foot was effected over the use of sand cast pipe with lead joints. Again, the use of dipping needles, electric pipe locators, aquaphones and accurate records of underground piping, all add to the economical and efficient operation of the department.

The annual valve inspection had just been completed at the time the report was made and the engineer, Joseph W. Straub, reported that it was gratifying to note the excellent condition of same. Out of the total number of 1,625 inspected only two were found out of order and two were found closed which should have been open. The fire hydrants were all in first class condition. On August 5, 1927, the city began introducing copper service lines, the first one being a two inch line. From that date until April 1, 1928, ten ¾ inch lines had been installed.

"Water Diviners" in England

The Brigg Urban Council, England, some time ago employed a "water diviner" to locate water for the borough. Upon his advice they bored at a certain place and at a depth of 350 feet had failed to find water, the drilling contractor expressing the opinion that all possible water-bearing strata had been passed through in that depth. Against the advice of its engineer, however, the council has decided to call in another water diviner to advise whether or not water can be obtained at a still lower depth. Already the council has spent 500 pounds in these operations.

There seem to be a number of municipal officials in England who still have faith in water diviners and the subject has been more or less seriously discussed at a number of the meetings of water work officials and civil engineers in that country.

Albany's Air Port

Albany, New York, has purchased about 300 acres of land approximately 8 miles northwest of the city which it is developing into an airport. Already an area about 2,500 feet square has been prepared to serve this purpose and has been in use for several months as a landing field for air mail from the west. An administration building is practically completed, as are hangars, both of which were built by local contractors, while the general contract for grading and preparation of the field was let to the Airport Construction Corporation, of New York.

Following the completion of this first area, contracts have been let for grading and otherwise preparing the remainder of the 300 acres, all of which will probably be ready for use by the end of the season.

The area purchased was originally all covered with second growth and old stumps of the timber which had been cleared off. In addition to removing these, the contractor has to do leveling off which averages very little over the entire area, but runs into a maximum cut of 8 to 10 feet at certain points.

Road Reconstruction in Saxony

Saxony, Germany, is contemplating the reconstruction of its entire system of state roads, embracing some 2,195 miles, the work to be completed within a period of six years. The principal points in the scheme are the repair of old roads, replacement of old macadam roads by asphalt and stone roads, and the construction of detours to avoid hills.

At present 1,020 kilometers are of asphalt or tar, 536 are of Kleinpflaster (small granite stones 9 to 11 centimeters thick and 8 to 12 centimeters square), and 60 kilometers are other high-class pavements. Asphalt roads are considered to be very suitable for Saxony state roads on account of the subsoil and climatic conditions and to be especially valuable in connection with repair work. About 3½ kilometers of concrete road were built in Saxony for experimental purposes in 1925-1926 and proved unsatisfactory, but this is stated by private and municipal road engineers of Saxony to be due to the use of obsolete machines and poor methods of construction.

It is proposed to give the macadam roads asphalt and tar surface treatment for the present and possibly convert them into straight asphalt roads within the six years of reconstruction.

Road construction engineers say that it may be possible to develop a satisfactory market for American road construction machinery, especially for finishing the surfaces of concrete roads.

County Highway Equipment in Colorado*

The use of up-to-date equipment has made it possible for many of the counties to cut their maintenance costs in half and to do about four times as much, according to road engineers. All but a few of the counties keep their organizations at work throughout the year.

In the past the counties have been using mostly graders with trucks as motive power. But grad-

*From "Colorado Highways," official publication of the state highway department.

ually these are being replaced with tractors and motor graders. Roads that were gone over with a team once a year, are now gone over with a scraper 10 to 15 times a year. Big grader outfits with heavy tractors are being used to widen and drain narrow roads at a fraction of the cost by the old method of team and labor. By the use of big graders grubbing is eliminated which makes a big saving. Instead of plowing, all dirt roads are scarified, thereby making another saving. A grader type of scarifier is used.

A large number of the counties of the state have well-equipped repair shops to keep the machinery in smooth running order. In this way the county is enabled to purchase all supplies, tools and oils at wholesale, thus effecting a big saving to the taxpayers over the old methods. The employment of highway engineers and road superintendents by the larger counties has been another factor in road improvement in Colorado, by helping to get the best returns for the money.

Activated Sludge Plant at Beddington, England

Surface aeration activated sludge plant in three stages with flexible operation using stages in series or parallel

The Beddington, England, sewage works at Croydon have recently been rebuilt and a new plant was completed in April of this year, having been begun in March, 1927. The old plant consisted of sedimentation tanks and percolating filters but these had reached their capacity and it was difficult to dispose of the sludge from the former, and it was desired to construct a new plant which would produce an inodorous sludge whereby the present method of sludge disposal (on land) could be continued with a minimum of nuisance, and produce an effluent sufficiently superior to the existing tank effluent to enable the filters to be worked at a higher rate. It was decided that an activated sludge plant would most likely meet these requirements, and the designers decided to use the "Simplex" surface aeration system to treat about one million gallons per day. One of the chief objects aimed at was complete elasticity of control, to enable the method of operation to be varied to suit any particular circumstances.

The sewage channel below the grit chamber narrows to a width of six feet, and here is placed a rectangular weir five feet wide provided with an automatic recording gauge.

The tank treatment is divided into three stages. There are six aeration tanks, each 25 feet by 27 feet 9 inches by 13 feet deep, with side walls extending vertically to a depth of 5 feet 6 inches, then battered at an angle of about 40 degrees to form a base 8 feet square. There are twelve settling tanks, also with hopper bottoms, eight for the first and second stages being 16 feet by 13 feet by 18 feet 3 inches deep, and the other four for the third stage being 12 feet 3 inches by 13 feet by 17 feet 11 inches deep. The

sides of the hoppers in the settling tanks are battered at an angle of about 65 degrees.

After passing over the gauging weir, the sewage is dosed with activated sludge and then enters the two first-stage aeration tanks, flowing from west to east, and is here aerated and passes over weirs into an effluent channel, where there is a cut-water plate which divides the effluent in any desired proportion, part entering the first-stage settling tanks, and the remainder passing on to the second-stage aeration tanks where it is again circulated and aerated, flowing from east to west. The effluent from these is again divided, part entering the second-stage settling tanks and remainder passing on to the third-stage aeration tanks. The latter part is again aerated flowing from west to east and the effluent collected as before. The whole of this effluent is passed to the third-stage settling tank.

Effluent entering the settling tanks of each stage is stilled in deflector boxes, sludge settling to the bottom and effluent rising. The effluent from these overflows into the main effluent channel.

When working as above, sludge from the first-stage settling tank is pumped into second-stage aeration tanks for re-aeration, and similarly that from second stage settling tanks is pumped into third-stage aeration tanks for further aeration. Sludge from third-stage settling tanks is pumped back to the distribution box at the inlet to be mixed with the incoming sewage, the surplus being pumped away onto land for drying. With this method of working, the third-stage settling tanks contain the whole of the sludge but only a portion of the water.

Instead of being operated in this way, by using the crude sewage feed pipes, the plant can be operated with the three stages in parallel, each stage thus making a separate and completely independent unit.

With the old plant, the average rate of operating the filters with sedimentation tank effluent was about 220 gallons per square yard per day, and it is hoped to work them up to about 400 gallons per square yard per day with the effluent from the new plant.

Sewage Treatment Results at Holland, Michigan

Holland, Mich., placed a sewage disposal plant in operation on March 2, 1927. This plant is for partial treatment of the sewage only and consists of a grit chamber, a pumping station, four Imhoff tanks, and sludge beds. The plant was designed to handle the sewage from a population of 22,000.

Matter collected by the screens ahead of the pumping equipment is burned or buried. Automatic float switches control the three pumps that lift the sewage through a venturi meter to the tanks. The sewage, clarified by going through the tank, is chlorinated and then discharged into Black Lake.

Each of the four Imhoff tanks is 56 feet long, 27 feet wide and 30 feet deep, and has a sludge storage capacity of 15,000 cubic feet.

During the ten months the plant operated in 1927, the average flow of sewage was 1,330,000 gallons. The largest average daily flow was in December with 1,727,000 gallons and the least was in August with 1,075,000 gallons. Averaging the entire year, the sewage flow totalled 98% of the amount of water

pumped, but the ratio varied considerably during the different months. It was the minimum in August and September, when it equaled 53.7% of the water pumped; and was maximum in December when the sewage pumped was 188% of the amount of water pumped. The report states that the low ratio of sewage to water during the summer months was caused by lawn sprinkling, but no explanation is given of the large excess of sewage in December. (It might be considered due to ground water entering the sewers but for the fact that the total precipitation for December was only .05 inch, while that during September, when the ratio was lowest, was 4.88 inches.)

Records for the three months, October, November and December during which chemical analyses were taken, show that the biochemical oxygen demand was reduced from an average of 189 in the raw sewage to an average of 128 in the Imhoff tank effluent; the oxygen consumed was reduced from an average of 73.7 to an average of 51.7, and the total solids from an average of 693 to an average of 548. In the case of both the oxygen demand and the oxygen consumed there was a regular progressive improvement in the percentage of reduction during the three months, being 43.2 and 39.0 per cent respectively in December. The reduction of suspended solids averaged 57.7%, varying from 59.5% in October to 54.1% in December. The dissolved solids remained practically the same in both raw sewage and effluent, the difference not exceeding more than $4\frac{1}{2}\%$ in any one month, which is within the limits of probable accuracy of determination.

The Downes Digestion Tank

Several articles have appeared in PUBLIC WORKS during the past two years describing some results of experiments in sewage treatment conducted by the New Jersey Agricultural Experiment Station, mainly upon the sewage treatment plant operated by Plainfield and Dunellen, New Jersey, of which John R. Downes is supervising engineer. In these, reference has been made to the separate digestion tanks operated in connection with this plant. These tanks have now been operating for about four years and apparently have proved most satisfactory. They were designed by Mr. Downes and are commonly known as the Downes separate digestion tanks.

The tanks are circular, 40 feet in inside diameter, and about 20 feet deep. The characteristic feature of them is the floating cover.

This cover, Mr. Downes informs us, was designed for the purpose of catching the foul odors characteristic of decomposing sewage and disposing of them by burning. It was found however that, with all the floating solids submerged by the weight of the floating cover, the worst of the odors did not develop and only the odor of illuminating gas can be detected in the collected gases. The cover floats freely on the surface of the sludge or upon the overlying gases, so that the gas is under a positive pressure equal to the weight of the cover. This precludes the entrance of air, avoids all danger of ex-

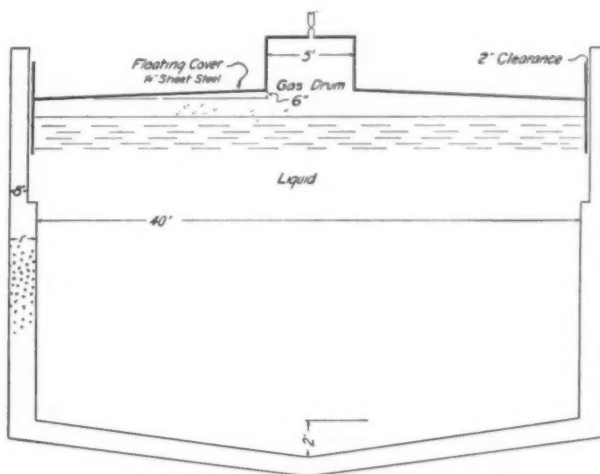
plosion, and maintains strictly anaerobic conditions which are most favorable to the desired digestion.

The cover is of quarter-inch sheet steel, four inches less in diameter than the inside of the top of the tank, and is slightly dished, being six inches higher at the center than at the sides. At the center is fastened a gas drum five feet in diameter, to the top of which is attached a gas pipe by which the gas is lead away. The base of the drum is wide open, with no screen or other contrivance for keeping out the sludge, and therefore there is nothing to clog. With the gas outlet properly restricted so as to maintain pressure, the whole cover is lifted out of the sludge before solids can reach the gas outlet, the solids being held down by the gas pressure. These covers have been in use for the past four years and no solids or foam have ever reached more than 8 inches above the bottom of the gas dome, since at this point equilibrium of weight of cover and pressure of gas is established.

A vertical flange extends around the edge of the floating cover, downward in order to trap the gas, and upward in order to furnish the necessary flotation. The two-inch clearance between this flange and the inside wall of the tank represents less than two percent of the surface area of the tank, and there is a 4-inch off-set all around the inside of the wall below the flange, which serves to deflect the gases away from this two-inch annular opening. The result is that a very small percentage of the evolved gas escapes through this clearance opening.

The gas is used for heating and for the operating of gas engines which drive air compressors.

In operation, sufficient supernatant liquid is drawn from the top of the tank before any fresh solids are admitted to it from the Imhoff tank, the object being to withdraw the supernatant before entering solids have stirred up the settled solids in the tank, the liquid withdrawn thus being clearer than it would be after the entrance of the fresh material. As the liquid is withdrawn, the cover falls, keeping always in contact with the liquid surface or the gas above it. When the fresh solids are run into the tank, the cover, of course, rises with the liquid. The tank is then left in a quiescent state until the next day, when again the supernatant is withdrawn and fresh solids admitted.



DOWNES' SLUDGE DIGESTION TANK

Recent Legal Decisions

SECTION LINE HIGHWAYS

There is no provision in the South Dakota Revised Code which permits section line highways to be changed by agreement of adjoining landowners; and a county is not precluded from moving a section line highway to the true section line by an agreement between adjoining landowners as to the location of the section line, in which agreement it did not acquiesce. *Kreider v. Yarosh*, South Dakota Supreme Court, 217 N. W. 640.

COUNTY'S RIGHT TO INSURE AGAINST INJURY TO WORKMEN ON HIGHWAY CONSTRUCTION

The Kansas Supreme Court holds, *Robertson v. Board of Commissioners of Labette County*, 261 Pac. 831, that a board of county commissioners in building a hard-surfaced road under the present statutes of the state, where workmen are employed and machinery is purchased for the purpose of building the road, has implied authority to purchase and pay for insurance covering injury to workmen while engaged in such employment.

STATE FAIR GROUND HELD "PUBLIC MUNICIPAL PURPOSE"

The term "public purpose," in connection with the taxing power of the state, is not to be construed too narrowly. It is not necessary, in order that a case may be regarded as public, that it should be for the use and benefit of every citizen in the community. It may be for the inhabitants of a restricted locality, but the use and benefit must be in common, and not for particular persons, interests, or estates. The determination of what is and what is not a public purpose belongs, in the first instance, to the legislative department; but the legislative determination of the matter is not conclusive; in its final analysis, it is a question for the courts. A state fair ground, situated in the vicinity of a city, not more than five miles from the state capital was held a "public municipal purpose," for which a donation by the city of public funds, provided by statute might be authorized by vote. *Briggs v. City of Raleigh*, 195 N. C. 223, 141 S. E. 597.

DAMAGE TO ABUTTING PROPERTY BY ABOLISHING SIDEWALKS

The Oklahoma Supreme Court holds, *City of Tulsa v. Hindman*, 261 Pac. 910, that where a city widens or opens a street for automobile and motor truck traffic to its entire width, thereby consuming all space theretofore assigned and set apart for sidewalks or footroads, it is liable to abutting property owners for any consequential damages resulting to such property. The damage is the depreciation in the market value of the property.

CONVERSION OF HIGHWAY SUBCONTRACTORS' EQUIPMENT

A highway subcontractor left with the principal contractors his equipment, scrapes, machinery and other articles. On his return he found that the contractors had abandoned their contract with the state highway commission, and that certain of their property, together with his machinery and equipment had been taken possession of by the surety on the principal contractors' bond, and the subcontractor's

property had been sold and the proceeds used in connection with the completion of the highway. The subcontractor sued the surety for conversion. Judgment for plaintiff was affirmed, *Porter v. Alexander*, 195 N. Car., 5, 141 S. E. 343. It was held that the basis of the action was the loss to plaintiff by the defendants' wrongful assumption of dominion over his property, regardless of the sale; and that in the case of a conversion by wrongful taking, it is not necessary to prove a demand and refusal.

HIGHWAY CONTRACTOR HELD NOT LIABLE FOR MATERIALS FURNISHED ON INDEPENDENT SUBCONTRACTOR'S CREDIT

The Georgia Court of Appeals holds, *Southern Crushed Stone & Granite Co. v. Dorn*, 141 S. E. 59, that a principal contractor engaged by the state highway department of South Carolina to build a road in that state is not liable for the price of materials furnished solely upon the credit of another whom he procured to contract a part of the road as an independent subcontractor. The court applied the rule laid down in *Saul v. Southern Seating & Cabinet Co.*, 6 Ga. App. 843, that "when one person has sold and delivered goods to another, and the detriments and benefits which constituted the consideration of the contract between them have been suffered and received, and the transaction has become fixed as to the reciprocal liabilities, a contract by a third person, not originally bound, to pay the debt thus already pre-existing and incurred by the purchaser, is nudum pactum, unless supported by some new consideration.

ENGINEERING SERVICES EXTENDING BEYOND FISCAL YEAR HELD CONTINUING CONTRACT

The North Carolina Supreme Court holds, *Gilbert C. White Co. v. City of Hickory*, 195 N. C. 42, 141 S. E. 494, that a contract with an engineering company requiring it to furnish necessary engineering services for a waterworks project, including surveys, specifications, drawings and the direction of the work, is a continuing contract, and therefore not invalidated because no appropriation was made therefor under the state Municipal Finance Act, the completion of the work requiring more than two years time, and the services contracted for extending over the fiscal year.

PROCEDURE TO EXERCISE OF POWER TO PAVE STREETS

Where the procedure to be followed by a city in the exercise of its power to pave streets is prescribed in the grant thereof, and no express direction is included therein for its initiation, but the charter contains a general provision elsewhere that "the board of commissioners shall be vested with all legislative authority of the city and shall exercise the same by ordinance; other action by them may be by order upon motion" it was held, *city of Mannington v. Hamilton*, 141 S. E. 527, that an order providing for certain paving, adopted by the board of commissioners of such city and complying in all other respects with the provisions of the charter, amounts to a substantial compliance with such charter provision.

NEWS OF THE SOCIETIES

Sept. 17-21—NEW ENGLAND WATER WORKS ASS'N. 47th annual convention at Montreal, Canada. F. J. Gifford, Sec'y, Tremont Temple, Boston, Mass.

Sept. 18-20—INTERNATIONAL CITY MANAGERS' ASSOCIATION. Annual convention at Asheville, N. C. John G. Stutz, Lawrence, Kans.

Oct. 3-5—AMERICAN SOCIETY OF CIVIL ENGINEERS. Fall meeting at San Diego, Cal. George T. Seabury, Sec'y, 33 W. 39th St., N. Y. C.

Oct. 8-9—INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS. Ninth annual conference at Toronto, Can. Geo. W. Dies, Toronto, Ont., Canada.

Oct. 13-15—CONFERENCE OF STATE SANITARY ENGINEERS. Annual meeting at Chicago, Ill. Hotel Stevens. A. P. Miller, Sec'y, Butler Bldg., Washington, D. C.

Oct. 15-18—SOUTHWEST WATER WORKS ASS'N. Annual convention at Dallas, Texas. L. A. Quigley, Sec'y, Fort Worth, Texas.

Oct. 15-19—AMERICAN PUBLIC HEALTH ASS'N. Annual meeting at Chicago, Ill. Homer N. Calver, 370 Seventh Ave., New York City.

Oct. 16-17—NATIONAL MUNICIPAL LEAGUE. Annual meeting at Cincinnati, O. H. W. Dodds, 261 Broadway, New York City.

Oct. 22-23—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention at Detroit, Mich.

Nov. 12-15—ASSOCIATION OF STATE HIGHWAY OFFICIALS. Annual convention at Chicago, Ill. W. C. Markham, Sec'y, National Press Bldg., Washington, D. C.

Dec. 10-14—ASPHALT ASSOCIATION. Seventh annual conference at New Orleans, La. J. E. Pennypacker, Mgr., 441 Lexington Ave., New York City.

NATIONAL HIGHWAY CONGRESS

The National Highway Congress will be held in Mexico City, Mexico, Oct. 3-6, 1928. The Congress has been organized under the auspices of the Mexican National Highway Commission. An exposition of road building machinery will be held in connection with the Congress, and demonstration of modern highway construction methods will be given. It is expected that the various Mexican states will be represented at this Congress. The officers of the Congress are: President, Ing. Ignacio Avilez; directors, Senores A. Gloria, G. Johns, R. Padilla, J. G. Hernandez and Ing. Jose Rivera R.; secretary, Sr. Juan F. Acosta, whose address is Calle Nuevo Mexico No. 90, Mexico, D. F. It is anticipated that machinery and material shipped from the United States for display in the exhibition will be permitted to enter Mexico duty free under bond, and that a reduction in freight rates will be made.

NEW ENGLAND WATER WORKS ASSOCIATION

The following members of the Water Works Manufacturers Association have applied for exhibit space at the convention of the New England Water Works Association which will be held in Montreal, Canada, Sept. 18-21.

Pittsburgh Equitable Meter Company; Thompson Meter Corporation; Neptune Meter Company; Water Works Engineering; The American City; Pittsburgh-Des Moines Steel Company; Engineering News Record;

Ross Valve Mfg Co., Inc.; R. D. Wood & Company; Lead Lined Iron Pipe Company; The Pitometer Company; United States Cast Iron Pipe and Foundry Co.; The Kennedy Valve Mfg. Company; National Tube Company; Hersey Mfg. Company; Builders Iron Foundry; The Canadian Engineer; Geo. A. Caldwell Company; The Federal Meter Corp.; The A. P. Smith Mfg. Co.; Paradon Mfg. Company; Union Water Meter Company; W. & L. E. Gurley; National Meter Company; Red Hed Mfg. Company; McWane Cast Iron Pipe Company; Wallace & Tierman Company, Inc.; Public Works (Journal); The Central Foundry Company; Worthington Pump & Machinery Corp.

AFFILIATED TECHNICAL SOCIETIES OF BOSTON

New officers have been elected by the Boston Section of the American Institute of Electrical Engineers as follows: Chairman, H. B. Dwight; vice-chairman, W. H. Colburn; sec'y-treas., G. J. Crowdes; members of the executive committee (2 years), R. G. Porter, J. P. Alexander, W. S. Edsall; affiliation counselor, E. W. Davis.

Following offices hold over for another year: Members of executive committee, C. A. Corney, Ernest Shorrock, H. B. Wood; affiliation counselor, J. W. Kidder.

The Boston Section of the A. S. M. E. has elected officers as follows: Chairman, C. H. Chase; vice-chairman, F. S. Freeman; secretary, E. F. Burnham; members of executive committee—E. W. Norris, M. D. Engle, C. W. Conrad; affiliation counselors, P. C. Idell, G. E. Seabury.

AMERICAN ROAD BUILDERS ASSOCIATION

Capt. H. C. Whitehurst, Assistant to the Engineer Commissioner of the District of Columbia, has been elected president of the City Officials Division of the American Road Builders' Association.

The new division adopted a constitution and formulated plans for carrying out the objectives for which the division was organized. Chairmen of four major committees were subsequently appointed. Captain Whitehurst heads the Committee on Administration and Organization; George B. Sowers, Cleveland, the Committee on Design and Construction; C. E. Myers, Philadelphia, the Committee on Maintenance; and M. O. Eldridge, Washington, the Committee on Traffic. Each of these committees will have various sub-committees.

The following officials and members of the board of directors were elected:

President, Capt. H. C. Whitehurst, Washington, D. C.; Secretary, Chas. M. Upham, Washington, D. C.; Treasurer, James H. MacDonald, New Haven, Conn.; Vice-presidents, C. E. Myers, Philadelphia, Pa.; Ben S. Davison,

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CLEANER

Cities in 34 states and Canada are now using this Cleaner to their satisfaction. It is dependable, economical and easy to operate. Take advantage of our six days trial offer—it will convince you that it will do all we claim for it, namely, a first class job of sewer cleaning.

It will at times save its cost on one job. Send for booklet describing our Cleaner also free samples of Sewer Rods.

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332 Chicago Avenue
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AYER & LORD TIE Co.

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CHICAGO

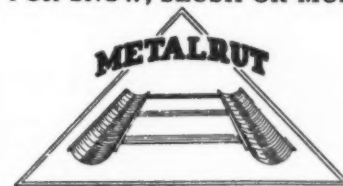
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FOR IMPASSABLE ROADS

Wood runways to keep trucks from becoming mired in mud, slush or boggy ground must be replaced frequently. Replacements eat into profits.

Metalrut is built to be used again and again—the initial cost is the last. The ten-foot sections are easy to handle and to store.

Write for details.

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Directors—Robert B. Brooks, J. P. Broome, W. P. Cottingham, R. M. Gregory, W. J. Jamieson, Chas. Henry Moon, Bryson Vallas, A. D. Butler, C. E. Clarke, Thomas B. Crutcher, Wm. A. Hansell, H. C. McClure, H. E. Nettleton, Ira T. Redfern, A. Mason Harris, O. Laugaard, Thos. B. Oakley, Harry C. Shaner, Nathan L. Smith, Geo. B. Sowers, James H. Sullivan.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

R. F. Schuchardt, Electrical Engineer, Commonwealth Edison Company, Chicago, was elected President of the American Institute of Electrical Engineers for the year beginning August 1, 1928. Other officers elected were: Vice-Presidents E. B. Merriam, Schenectady, N. Y.; H. A. Kidder, New York City; W. T. Ryan, Minneapolis, Minn.; B. D. Hull, Dallas, Tex.; G. E. Quinan, Seattle, Wash.—Directors A. E. Bettis, Kansas City, Mo.; J. Allen Johnson, Niagara Falls, N. Y.; A. M. MacCutcheon, Cleveland, Ohio—National Treasurer George A. Hamilton, Elizabeth, N. J. (re-elected).

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These officers, together with the following hold-over officers, will constitute the Board of Directors for the next administrative year, beginning August 1: Bancroft Gherardi (retiring President), New York City; C. C. Chesney, Pittsfield, Mass.; O. J. Ferguson, Lincoln, Neb.; E. R. Northmore, Los Angeles, Calif.; J. L. Beaver, Bethlehem, Pa.; A. B. Cooper, Toronto, Ont.; C. O. Bickelhaupt, Atlanta, Ga.; M. M. Fowler, Chicago, Ill.; E. C. Stone, Pittsburgh, Pa.; I. E. Moulthrop, Boston, Mass.; H. C. Don Carlos, Toronto, Ont.; F. J. Chesterman, Pittsburgh, Pa.; F. C. Harker, East Pittsburgh, Pa.; E. B. Meyer, Newark, N. J.; H. P. Liversidge, Philadelphia, Pa.

The annual report of the Board of Directors, presented at the meeting, showed a total membership on April 30, 1928, of 18,265. In addition to the three national conventions and four Regional meetings, 1346 meetings were held by the local organizations in the principal cities and educational institutions in the United States and Canada.

AMERICAN WATER WORKS ASSOCIATION—CENTRAL STATES SECTION

The annual meeting of the Central States Section, American Water Works Association, will be held at Huntingdon, W. Va., on August 23 and 24, with headquarters at the Hotel Prichard. E. E. Bankson, 813 Clark Bldg., Pittsburgh, Pa., is secretary.

PERSONALS

E. M. Knox was appointed city manager of High Point, N. C., effective June 15. Mr. Knox comes from Chapel Hill, North Carolina where he has been city manager since June, 1922.

James Rippey has been appointed town manager of Windsor, N. S.

E. J. Donnelly has been appointed city manager of Two Rivers, Wisc. Mr. Donnelly goes to Two Rivers from Ontonagon, Michigan, where he has been doing special platting and engineering work for the city.

H. W. Coleman, formerly, city manager of Quincy, Florida, has been appointed city manager of Stevens Point, Wisc.

L. A. Sears, city manager of Albion, Michigan, since January, 1926, has been appointed city manager of Oberlin, O., effective September 1.

L. M. Fisher, sanitary engineer of the U. S. Public Health Service, has

been transferred to New York City to assume charge of Interstate Sanitary District No. 1. Mr. Fisher, who was formerly stationed at Providence, R. I., succeeds E. C. Sullivan at New York.

R. E. Tarbett, sanitary engineer, U. S. Public Health Service, has been transferred to Washington, D. C., and will assume charge of Public Health Engineering Abstracts, succeeding A. P. Miller, associate sanitary engineer.

Dewey Elliff, formerly of Clinton, Oklahoma, has been appointed city engineer of Iola, Kansas.

C. E. Guenther, for the past seven years superintendent of the Horton, Kansas, municipal water and light plant, has been appointed superintendent of the water and light plant of Wellington, Kansas.

Paul B. Wolf has been appointed assistant highways engineer of Baltimore, Md.

L. J. Sverdrup, formerly chief bridge engineer of the Missouri Highway Department and J. I. Parcel, professor of structural engineering of the University of Missouri, have formed the firm of Sverdrup and Parcel. Their offices will be in St. Louis and they will specialize in bridges, building and foundation work.

Harrington, Howard and Ash, consulting engineers, Kansas City, Mo., have dissolved partnership. Mr. Harrington and F. M. Cortelyou have formed the firm of Harrington & Cortelyou; Mr. Howard and Mr. Ash have, with H. C. Tammen and E. R. Needles, established the firm of Ash-Howard-Needles and Tammen. Offices of both firms will be established in Kansas City and New York.

The city commissioners of Pittsburgh, Kans., have appointed W. E. Robinson city engineer to fill the vacancy caused by the resignation of L. D. Cornelius.

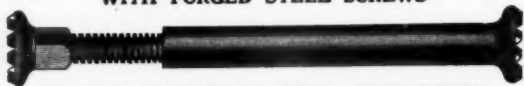
Webster Kehr has been appointed to fill the position of assistant engineer of the Kansas State Board of Health made vacant by the resignation of R. E. Lawrence. Mr. Kehr is a graduate in Civil Engineering of the University of Kansas and has been employed for some time by the Kansas Highway Commission.

Quincy A. Campbell has been appointed Acting Secretary and Assistant to the Managing Director of the National Paving Brick Manufacturers Association. Mr. Campbell entered the Ohio Department of Highways as an Assistant Engineer in 1921, later being appointed Assistant Division Engineer and serving in that capacity at Ravenna, Ohio, for five years. In 1927 he was promoted to the position of Assistant Chief Engineer of Maintenance, with headquarters at the Columbus office of the Ohio State Highway Department, which position he has resigned to enter his present employment.

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WRENCH FREE WITH EVERY TWO DOZEN

Not excelled for narrow and medium width trenches. Mud guards desirable where concrete or mud hardens on braces. The only brace that is free from projections that hinder workmen in the ditch. Kalamazoo timber brace fittings are suitable for wider trenches.

KALAMAZOO FOUNDRY & MACHINE CO.

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Kalamazoo, Mich.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

Link-Belt 2-Yard Shovel

Link-Belt Company, Chicago, Indianapolis and Philadelphia, has announced the addition of a full 2-yard capacity machine to their line of crawler cranes, shovels and draglines. Heretofore the largest capacity machine built by this company was a 1½

bronze-bushed crawler rollers; enclosed cut gearing and bronze-bushed bearings throughout, other details include:

Internal expanding friction clutches of unusual size and power, the main drum clutches being 42" in diameter; and swing and travel clutches, 30" diameter; a 13½" diameter center pin, adjustable from above which can be removed as a unit with the vertical travel shaft assembly, without removing any other parts; large drums with renewable cast steel shells, having air space between clutch and brake surfaces, for rapid cooling; and large, powerful drum

Austin-Western Portable Crushing Plants

The Austin-Western Road Machinery Co., Chicago, Ill., manufactures Austin portable gravel screening and crushing plants for use with 100-type Austin Gyratory Crushers. A typical plant consists of a 50-ft. portable conveyor, 12-ft. revolving screen, 15-yd. two compartment portable steel bin and No. 104 Austin Portable Gyratory Crusher, with folding elevator. The conveyor brings the gravel to the revolving screen which has four feet of ½ inch perforations to take out the sand, and eight feet of 1-inch perforations. The oversized material passes out the end of the screen and down a chute to the crusher. After being crushed, it is returned to the screen again, and a grizzly spout diverts the stone chips to the second compartment of the bin instead of permitting them to drop through the first screen section into the sand.

The Western Road Metal Plant is completely portable and recommended for reducing all sizes of gravel to a designated maximum such as 1-inch. Crusher, screen and return elevator are mounted on the same truck. The Western Aurora Jaw Crusher is used with Western Road Metal Plants. This crusher has an hourly capacity ranging from 5 to 25 tons, depending upon the size of crusher used.

The gravel is brought to the screen by a portable conveyor. Either the shaker type of screen, or a double rotary screen may be used. The material smaller than the designated maximum—which in most localities is now 1-inch—drops through the screen and is transported directly to the bin. The oversized material passes out the end of the screen into the crusher, and after being crushed is brought back to the screen by the return elevators.



WESTERN ROAD METAL PLANT

yard unit, and the new machine is indicative of the trend toward more powerful machines of great capacity.

The Link-Belt K-55, as the new machine is known, is a powerful, heavy duty, all-purpose, 2-yard machine, primarily designed for the following adaptations: Shovel with 30-ft. boom and 18-ft. dipper stick carrying a 2-yard struck-measure-capacity all-manganese-steel dipper; Drag-line to handle 2-yard dragline bucket for medium and medium-heavy excavating, on boom 50 ft. long; or a 1½-yard drag-line bucket on boom 60 ft. long; Clam shell bucket of 2-yard capacity, for sand, gravel or materials of equal weight per cubic foot, and consistency, on boom 50 ft. long; or a 1½-yard bucket, in such materials on boom 60 ft. long; or, of course, an equivalent weight of loaded bucket in heavier or lighter materials; Trench shovel, 2-yard capacity.

All attachments are interchangeable without removing or disturbing the mechanism of the machine proper.

The K-55 is said to be the only machine of, or near, its capacity which does not require extensive dismantling and preparation for shipment. The K-55 has a collapsible mast, and special shipping treads which may be quickly and easily substituted for the working treads, to bring the machine within the railroad clearance requirements of 10' 4" overall width and 16' 0" overall height above top of rail when loaded on flat car.

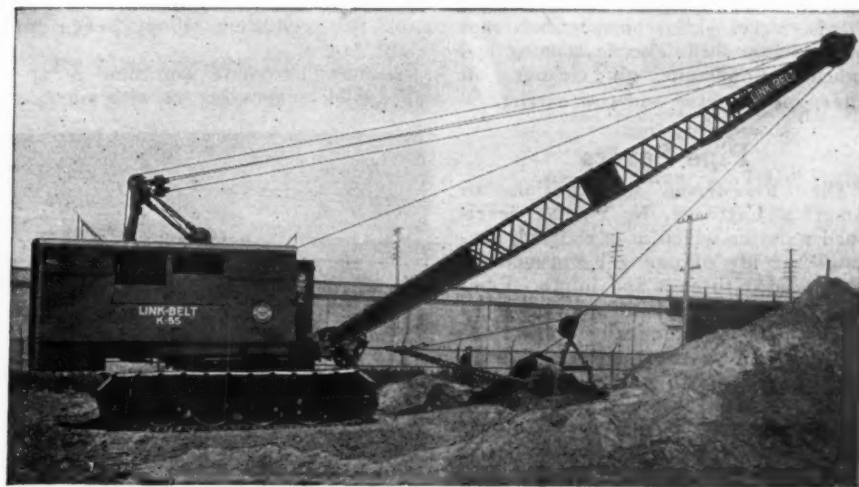
Besides the unit cast steel construction of lower and upper frames; self-cleaning crawler treads and large

brakes, 48" diameter by 5" wide. The machine in working condition is 12 ft. wide overall at the lower frame, which gives it ample stability for the work for which it is designed. Crawler treads are 36" wide. The K-



AUSTIN GYRATORY CRUSHER

55 is built to be driven with gasoline engine, electric motor or Diesel Engine drive.



LINK-BELT K-55 EQUIPPED AS DRAGLINE

If it is desired to remove the sand, a device for either type of screen can be supplied, which takes out the sand immediately, and diverts it to a separate delivery conveyor.

Delivery of the finished product from plant to bin is made either by a bucket type of elevator or a belt conveyor.

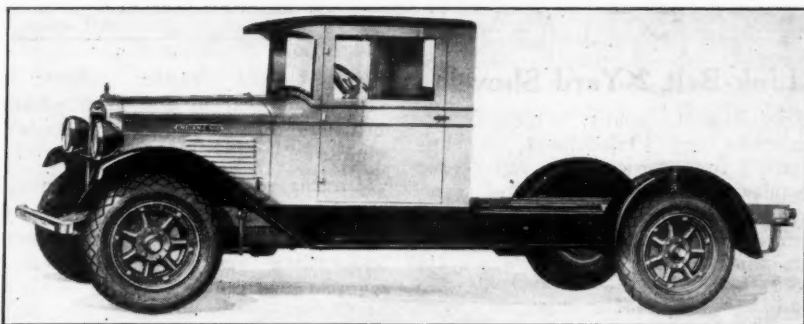
Indiana Ranger One Ton Motor Truck

The Indiana Truck Corporation, of Marion, Indiana, has recently brought out a new one-ton, six-cylinder chassis, known as the Indiana Ranger, Model 200. This model is powered with a six cylinder, valve-in-head engine, 3¼-inch bore by 4¼-inch stroke. It has a piston displacement of 211.5 cubic inches and develops 45 brake horsepower. Mechanical four wheel brakes of the internal expanding type are standard equipment on this model. The wheelbase length is 137 inches. The engine, clutch, transmission, propeller shaft, front and rear axles, steering gear, frame, springs and wheels are especially designed for motor truck use.

The patented Tors-Elim 3-point mounting of cab, motor and radiator units, is used on this chassis. This mounting is claimed to prolong the life of the truck

Pipe-Savers are very cheap, and actual test service for three and a half years on lines where replacements previously have been frequent shows the

The absence of volatile solvents and cut-back ingredients, it is said, serves both to retain all the essential properties of pure asphalt and to make the



INDIANA "RANGER" ONE-TON, 6-CYLINDER CHASSIS

economy of their use. They are especially suited for use in high pressure steam lines, for carrying corrosive liquids, and in water works where leaky joints are troublesome.

Pipe-Savers are made in sizes from 1 inch to 4 inches.

Asphalt Chromate Emulsion

E. I. du Pont de Nemours & Co., Wilmington, Del., announce that the Paint and Varnish Division of that company has perfected a radically new

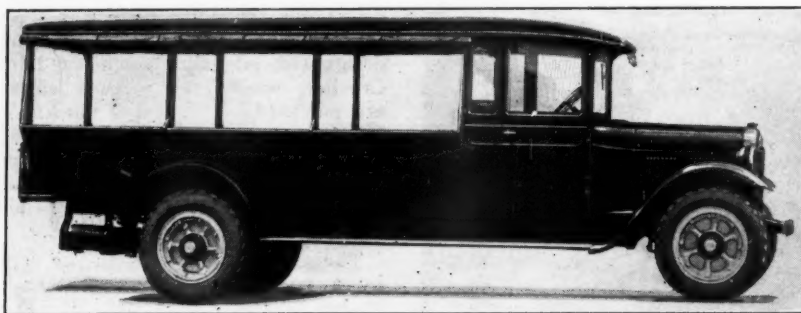
use of the new compound safe in confined spaces, there being given off no noxious fumes nor explosive vapors.

The material is intended for the same general purposes as melted asphalt or asphalt paint for the protection of iron and steel and as a wood preservative.

Graham Brothers New 6-Cylinder 2½-Ton Canopy Truck

Graham Bros., Detroit, Mich., have brought out a 2½-ton truck which because of the exceptionally large space for transporting construction materials, is especially suited to the needs of most public utilities companies. Among the important features are power and speed, flexibility, a six-cylinder engine, single-plate clutch, four-speed heavy duty truck transmission, and Lockheed hydraulic internal expanding brakes operating in sixteen inch drums on all four wheels. The hand brake operates on an eight inch drum on the propeller shaft.

The combustion chambers in the cylinder head are completely machined in order that all six explosions shall be of exactly the same intensity. This refinement, and large crankshaft and main bearings insure smoothness of operation and freedom from engine vibration. A water temperature indicator is mounted on the instrument panel and a thermostat is provided to control the temperature of the water in the cylinder jackets. A shutter is fitted to the radiator to enable the driver to warm the engine up more



GRAHAM BROS.' NEW 6-CYLINDER, 2½ TON CANOPY TRUCK

and add to its easy riding qualities. The radiator, hood, cowl and cab maintain their position substantially as a single unit, independent of the chassis, and free from torsional strains and vibration.

Standard equipment on the Ranger chassis includes Moto-Meter, full crown front and rear fenders with running boards, nickel plated bumper, hub caps and radiator shell, electric starting and lighting equipment, air cleaner, oil filter, speedometer and tire carrier.

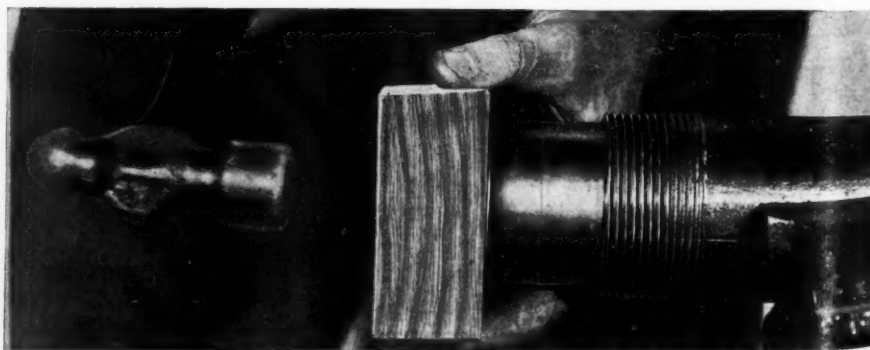
Pipe Savers

The Pipe-Saver Corporation of America, Carthage, N. Y., has developed a device which, it is claimed, prolongs the life of piping by preventing corrosion at threads and joints. Pipe-savers line the ends of pipes with a metal that is practically impervious to the action of steam, water and acids. Their use is very simple. After the pipe has been threaded and reamed ready for fitting, a pipe-saver is dipped in oil and seated in the pipe by striking on a block of wood, as shown in the illustration.

method of manufacturing asphalt paint by mechanical emulsification of asphalt and water and the addition of chromium salts.

The chromium salts are introduced as a rust inhibitor, which makes ferrous metal "passive" to corrosion while the water of the emulsion is drying out, this requiring about seven to eight hours.

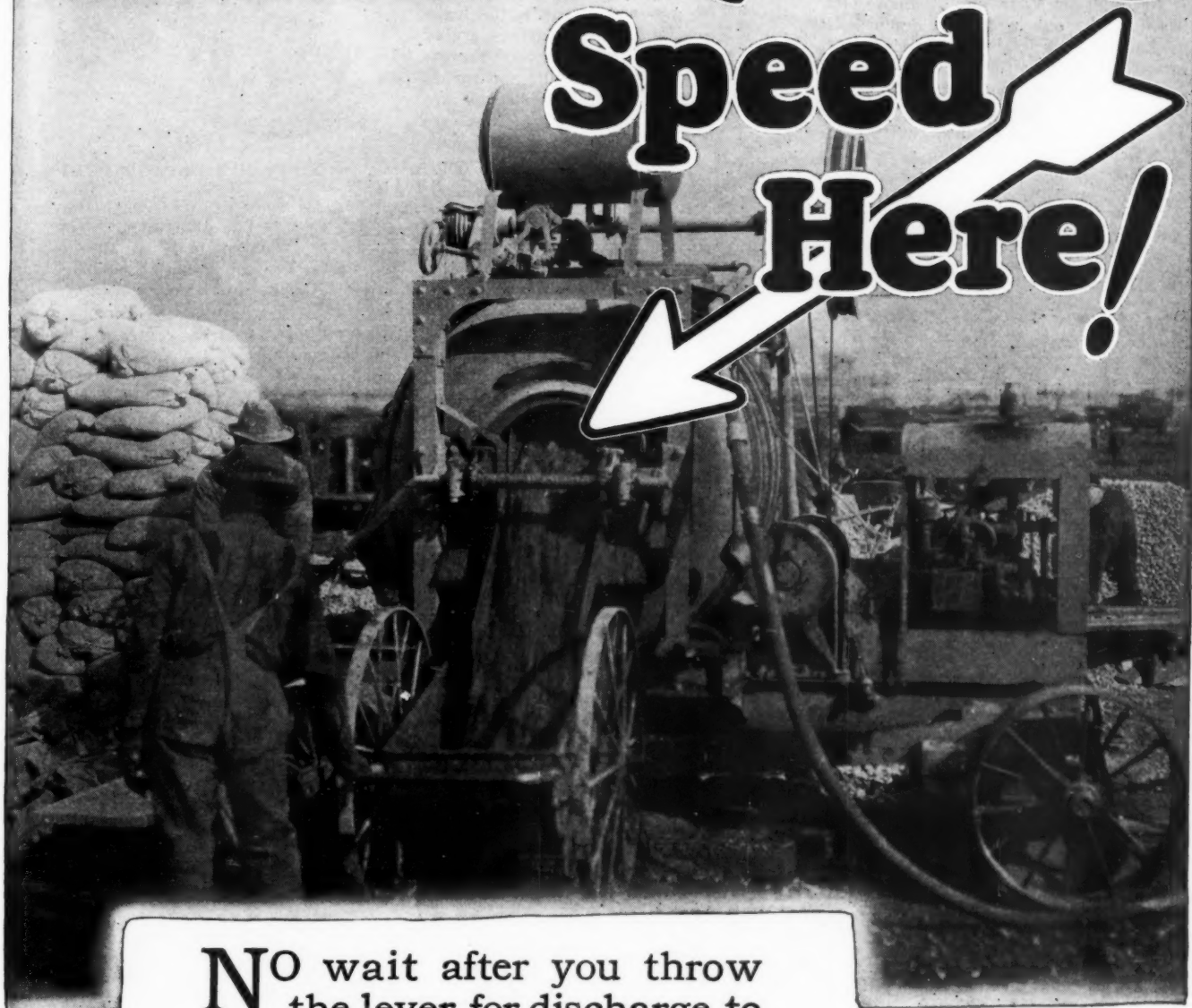
Asphalt chromate emulsion is applied cold by spraying, or with a brush.



USING A PIPE SAVER

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Speed Here!



NO wait after you throw the lever for discharge to begin! It starts *instantly!*

—and, because of the Koehring construction pivoting the chute inside the drum, the large area inside the drum means quick, big volume of discharge maintained to the last handful of the batch! No dribbling at the last!

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Pavers—13-E, 27-E. Auxiliary equipment and choice of power to suit individual needs. Complies with A. G. C. Standards.

Construction Mixers—14-S, 21-S, 28-S. Steam, gasoline or electric power. Mounted on trucks or skids. Rubber tired wheels optional. 28-S on skids only. Complies with A. G. C. Standards.

Dandle Mixer—5-S, 7-S, 10-S:—5-S single cylinder, 7-S, 10-S, two or four cylinder gasoline engine. Power charging skip, or low charging hopper and platform. Rubber tired steel disc wheels or steel rimmed wheels. Complies with A. G. C. Standards.



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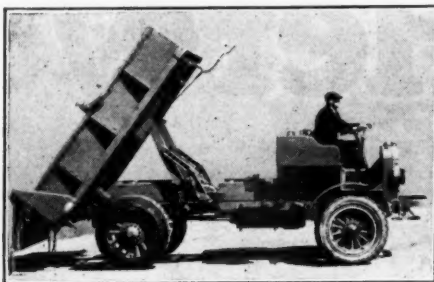
quickly and to keep it warm when the truck is standing. Both these features contribute to fuel economy.

The cab is unusually roomy and affords good vision.

Autocar Rotary Dump Hoist

The Autocar Company, Ardmore, Pa., has brought out a rotary dump hoist mechanism which, it is claimed, will raise the body to an angle of 60 degrees.

One of the most important features of the mechanism is the automatic cut-out which, as the name implies, cuts off application of the power just as soon as the body reaches the maximum elevation



AUTOCAR ROTARY HOIST

and similarly cuts off the power when the body has returned to full normal position. This requires no attention from the driver of the truck and he may put the truck in motion before the body has returned to normal.

The 60 degree dumping angle greatly increases the ease with which a wet batch of concrete may be dumped; and it is chiefly for use in the highway and construction industry that this hoist has been brought out.

Economy Multi-Stage Centrifugal Pumps

The Economy Pumping Machinery Co., Chicago, Ill., has placed on the market several sizes of hydraulically balanced multi-stage centrifugal pumps, as companions to its new line of double suction single stage pumps. These pumps have been especially designed for boiler feeding, heavy mill service, city water works, etc., where the velocities must be kept low enough for durability.

These new pumps are of the single suction design without diffusion rings but with a spiral or volute in every stage. This design makes possible an efficiency which approaches that of a single stage pump because the loss between stages is reduced to a minimum.

Solid bronze one piece diaphragms are used between stages. These diaphragms are tongued and grooved in the case so that there can be no leakage between the case and the diaphragm. The use of the one piece diaphragm does away with leakage between stages which occurs as a result of the case springing subject to high internal pressure. In the Economy design the length of gasket held by each bolt is very short.

The hydraulic balancing device is of the disc type located at the outboard end of the pump. Leakage at the high pressure stuffing box is controlled by a needle valve on the water seal. Stuffing glands are both of bronze of the split type designed to deflect leakage into the bearing yoke. Shaft sleeves are grooved to throw the leakage within the gland. Bearings are of the ring oiling type to prevent the escape of oil or entry of dirt or water. The cast iron renewable sleeves are babbitt lined. Bearing brackets are cast with the case and are fitted with spring oil covers and oil level cups. The pump shaft is of high carbon alloy steel turned and ground all over and fitted on centers. It is protected wherever exposed to the water by shaft sleeves extending through the stuffing boxes.

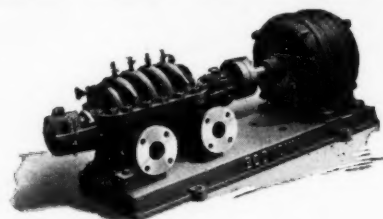
The head per stage is kept quite low in order to secure maximum efficiency and to reduce the velocity; the result is a pump which has a very light rotating element and which has a very flat horse power input curve.

"American" Gasoline Three-Speed Crane

The American Hoist and Derrick Co., St. Paul, Minn., has brought out a new gasoline three-speed crane, which has an automotive shift, low gear for starting, intermediate for average crane work and traveling, and high gear for rapid traveling.

This new "American" gasoline three-speed crane features many mod-

ern engineering principles of design. The machinery deck revolves on 20 bronze bushed conical rollers, which makes slewing easier and reduces the friction common when the deck re-

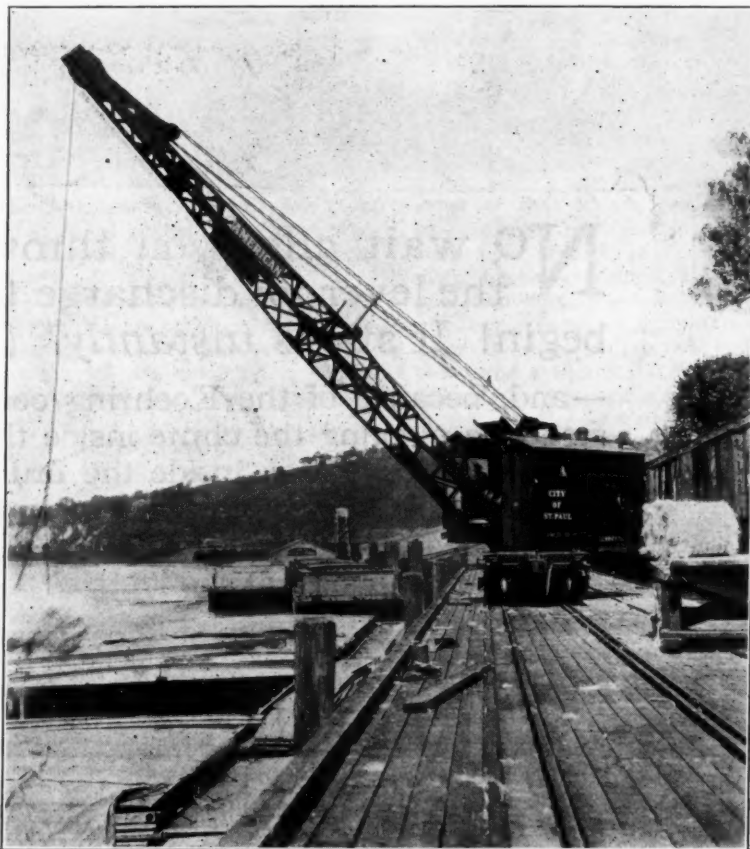


ECONOMY MULTISTAGE PUMP

volves on four or six wheels on an open track. The machinery deck is locked to the car body at the outer circumference of a bull gear by an Interlocking Gib Ring, which, it is said distributes the load and stresses instead of concentrating them on a king pin. The car body is of structural steel with Bethlehem Girder Beam Side Sills and solid semi-steel center casting to support the revolving mechanism, while the transmission is of the universal joint automobile type. Capacities from 12 to 30 tons.

Madsen Adjustable Volumetric and Weigh Box

The Madsen Iron Works, Huntingdon Park, Los Angeles, Calif., manufactures a combination adjustable volumetric and weigh box, which, it is claimed, is speedy, and accurate. The exact weight of material run out of each gate is registered on the dial. The box is easily adjust-



AMERICAN 3-SPEED GASOLINE CRANE

AMERICAN

AURORA, ILL.

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with **Anti-Friction Bearings**



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Omaha, Neb.	Birmingham, Ala.
Atlanta, Ga.	Joplin, Mo.
Charlotte, N. C.	El Paso, Texas
Pittsburgh, Pa.	Kansas City, Mo.
Roswell, N. M.	St. Paul, Minn.
Philadelphia, Pa.	Portales, N. Mex.
	Salt Lake City, Utah
	San Francisco, Calif.
	Vancouver, B. C., Can.

To meet the requirements of the pump buying public, the American Well Works announces the development of a high speed, double suction, centrifugal pump, suitable for motor speeds up to 3600 R. P. M. The rugged and inherent qualities the engineer has a right to expect of an American Well Works pump has been consistently maintained in both design and manufacture. The demand for anti-friction bearings has been met in this new line of pumps. They may be furnished either with sleeve or ball bearings.

The ratings on these pumps are conservative and are based on exhaustive tests on carefully checked and calibrated instruments. The attainment of the high efficiencies has not been made at a sacrifice of either simplicity or through skimping of shaft sizes or shortening of packing boxes. Disc friction losses are cut to the minimum through the use of a small diameter impeller. Precision workmanship and shop control guarantee the consistency of rated efficiencies.

Data on the "American" 1½ inch, double suction, centrifugal pump with, or without, anti-friction bearings is available for the asking. Performance curves are available to engineers.

THE AMERICAN WELL WORKS

General Offices AURORA, ILLINOIS and Factory

able and any desired volumetric measure up to 15 cubic feet of sand and 25 cubic feet of rock may be secured immediately.

Both the sand and stone compartments are graduated in cubic feet, the collapsible hinged sides being locked at the various capacities by means of tee head bolts sliding in slotted malleable iron guides. When the bolts are loosened, the sides can readily be pulled in or out to register with the capacity markings and easily tightened with an ordinary wrench. A platform type 5 to 1 quadruple weigh beam assembly, with dial scale, is interposed between the batch box and proportioning bin. This permits proportioning of all materials either by weight or volume without changing any equipment whatever. A single, broad drop-gate releases both sand and stone into the mixer or truck below. The weight of the materials opens the gate when a hand latch is tripped. A toggle lock then holds the gate wide open until the hand latch is again tripped. The gate

these bearings take all end thrust both ways from the clutches. Hyatt bearings are used on the gear end of shafts.

Malleable friction blocks are lined with "Hico" asbestos brake lining and blocks may be removed or replaced without taking assembly apart.

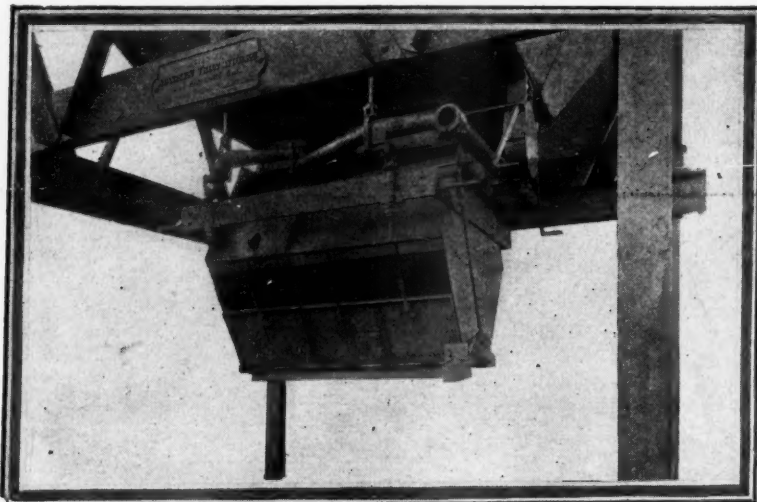
The friction clutches are engaged or disengaged by very slight pressure on clutch lever that controls thrust screw. The thrust screws are large size, mounted in removable bronze nuts and a Timken bearing placed between the end of the screw and the thrust pin.

The machined out gears have a 4" face. The silent drive chain from motor to drive shaft is enclosed.

Bronze bushings are used in both drums.

The drag line is powered by Waukesha 60 H. P. motor only.

The entire drag line mechanism should outwear the motor. The advantages claimed for this piece of



MADSEN VOLUMETRIC AND WEIGH BOX

being counterweighted then snaps shut and locks automatically.

The weigh beams are equipped throughout with fully equalizing knife edges and V blocks of ample dimensions to prevent undue wear. A single adjustable nose iron at the scale end of the beams makes it easy to correct any variation in scale readings with the actual weight in the box. The batch box compartments are filled from the bin through two special pivoted and geared duplex cut-off gates which open and close quickly and always deliver centrally. These gates act as automatic devices when proportioning by volume. The gate openings are very large and prevent bridging of material flow.

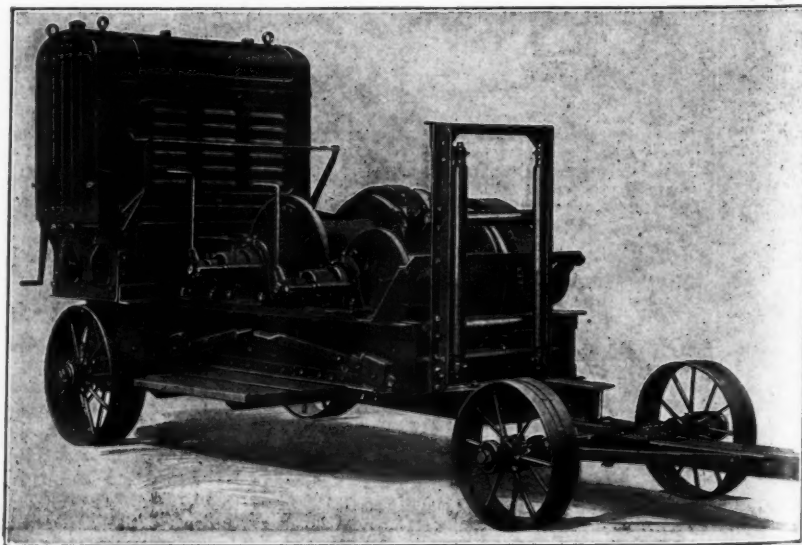
New Russell Drag Line

The Russell Grader Mfg. Co., Minneapolis, Minn., has developed a new drag line which is known as the Russell Drag Line No. 60, of which the principal features are:

The bed of the all steel, welded frame is accurately machined so that the all-journal brackets cannot get out of alignment.

The shafts are mounted in Timken bearings on the operator's side and

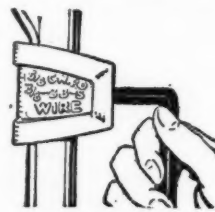
equipment, over any drum unit heretofore offered are long life, ease of operation and big saving in upkeep. On account of being fully mounted in roller bearings, it will save a great deal on power and deliver a greater capacity with the same size motor.



RUSSELL DRAG LINE NO. 60

Copperweld Grounding Wire Connection Clamp

The Copperweld Steel Company of Glassport, Pennsylvania, has developed a simple and effective grounding wire clamp, listed as standard by Underwriters' Laboratories, and designed to



COPPERWELD CONNECTION CLAMP

encircle the ground rod and securely bind the grounding wire directly to the driven member.

With this method no solder or heat is required, it merely being necessary to

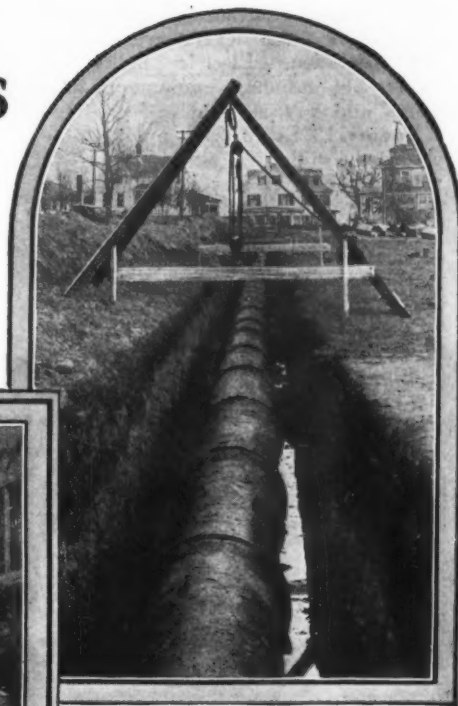
pass the grounding wire into the clamp which has been placed around the driven rod, then tighten by means of a set screw actuated by a set-screw wrench. So securely is the wire clamped to the driven member that, it is asserted, the wire is flattened against the rod thus increasing its contact surface and eliminating the possibility of slippage.

It is claimed that the clamp and wrench eliminate the usual melting pot, ladle and other solder equipment, and that it reduces the time needed to effect the connection from an average of 30 minutes to about two minutes. In addition, it provides a surety of connection that is not always attained by the soldering process even with the most skillful and painstaking labor.

Model B-2 Speeder

The Speeder Machinery Corporation, Cedar Rapids, Ia., have just introduced the Model B-2 Speeder, one-half yard, fully revolving, fully convertible shovel. The B-2 is a crawler type, powered with either gasoline engine (Hercules OX, 4x5) or electric motor, and is claimed to operate equally well as shovel, pull shovel, crane, dragline, pile driver, backfiller and skimmer. The cab is steel, weather-proof, and may be locked. Ease of control is claimed to be a special feature. All clutches are of the outside,

Reducing FIRST costs as well as *last* costs with CAST IRON PIPE



(above)
*An inexpensive crane for
placing pipe in position*



(at the left)
*Unloading 24" cast iron
pipe using skids*



*Much helpful data for the engineer
and contractor is contained in the
U. S. Cast Iron Pipe Hand book.
May we send your copy now?*

FIRST cost is usually the last cost with cast iron pipe... And proper handling methods will not only insure a lasting job, but also materially reduce the first cost of installation.

The illustration above shows the simple equipment necessary for handling efficiently medium-sized cast iron pipe. The use of the inexpensive crane illustrated speeds up the work, reduces labor cost and helps to make a better finished job.

Practical experience indicates that the use of labor-saving devices may save as much as 40% of the cost of laying mains with hand labor alone. Skillful handling and good equipment on the job always pay.

United States Cast Iron Pipe and Foundry Company

Philadelphia: 1421 Chestnut St.
Chicago: 122 So. Michigan Blvd.
Birmingham: 1st Ave. & 20th St.
Buffalo: 957 East Ferry Street
Cleveland: 1150 East 26th Street
New York: 71 Broadway

General Offices:
Burlington, New Jersey

San Francisco: 3rd & Market Sts.
Pittsburgh: 6th & Smithfield Sts.
Dallas: Akard & Commerce Sts.
Kansas City: 13th & Locust Sts.
Minneapolis: 6th Street &
Hennepin Avenue

double band, contracting type. Not more than three levers are used in any operation. Electric lights and starter are standard equipment; flood lamps and a spot light are provided.

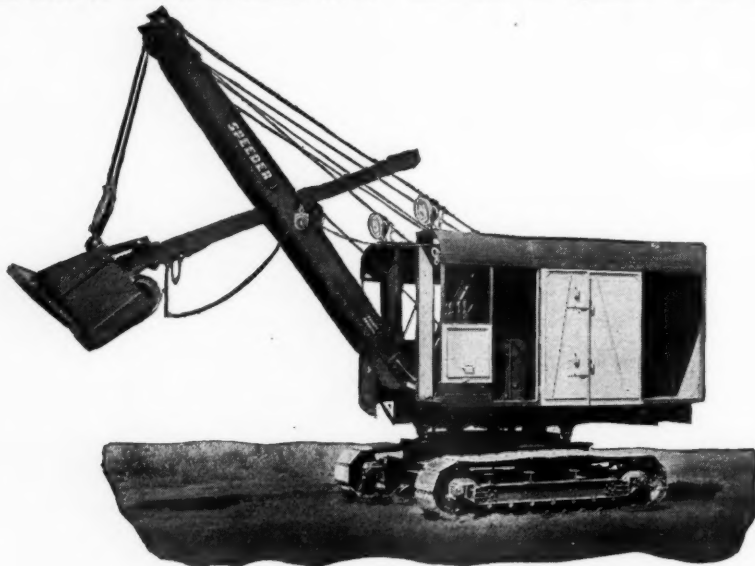
Booms 12 to 18 feet in length are provided, giving a shovel radius at tread level of 11 feet 11 inches to 15

Novo single drum hoists are light duty units, suitable for any work requiring a line pull of not more than 1600 pounds. Although many features, ordinarily found in larger, more powerful hoists, are incorporated in these hoists, they are low in cost and economical to operate. Novo single

1600 pounds. They are relatively light in weight, although constructed similar to larger, more powerful units. They are built on a strong frame, effectively preventing misalignment with consequent undue wear on bearings and gears.

These hoists have many other features, such as double cone hard maple friction, machine cut gears and patented screw thrust ordinarily found on larger, more powerful and costlier hoists.

Novo NH double drum hoists are powered with Novo two cylinder, 6, 8 and 10 HP Roller engines and Novo four cylinder 12-14 HP Rollr engines, and are also fitted with electric motors, 5 to 10 HP.



MODEL B-2 SPEEDER SHOVEL

feet; a maximum height of cut to 23 feet; a maximum dumping radius of 24 feet 4 inches; and a maximum dumping height of 20 feet 9 inches. Performance is equally good with pull shovel, skimmer and crane and dragline attachments.

The weight ready for working is about 29,000 pounds.

New Novo Hoists

The Novo Engine Co., Lansing, Mich., has just brought out their type NH single and double drum, gasoline and electric hoists.

drum NH hoists are so built that a second, or forward, drum may be added to the hoists at a later date, if so desired.

These hoists are built on an all-steel, electric welded one piece base. Welded-in tubular cross members provide stiffness which prevents the frame from getting out of alignment, reduces bearing wear, adds many years of service, and increases operating efficiency. NH hoists are powered with Novo single cylinder type S engine, two cylinder 6 and 8 HP Rollr Engines or 3 to 7½ HP electric motors.

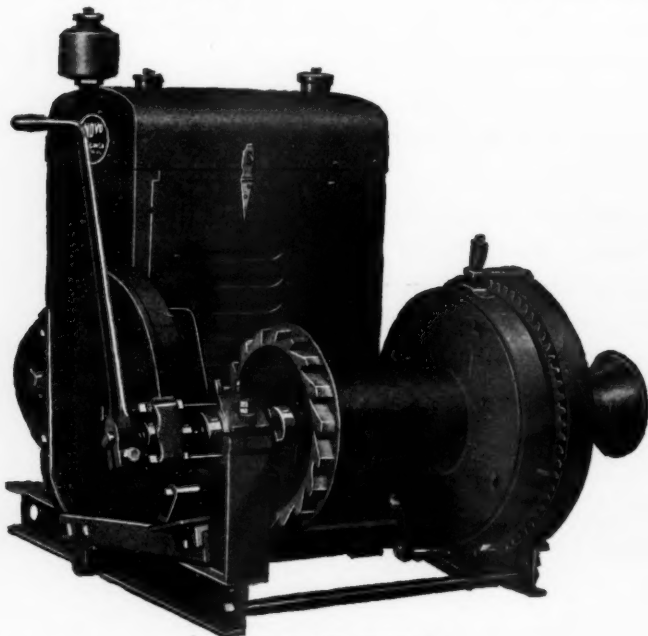
Novo NH Double Drum hoists are suitable for handling any load up to

Tri-Lok Concrete Armoring

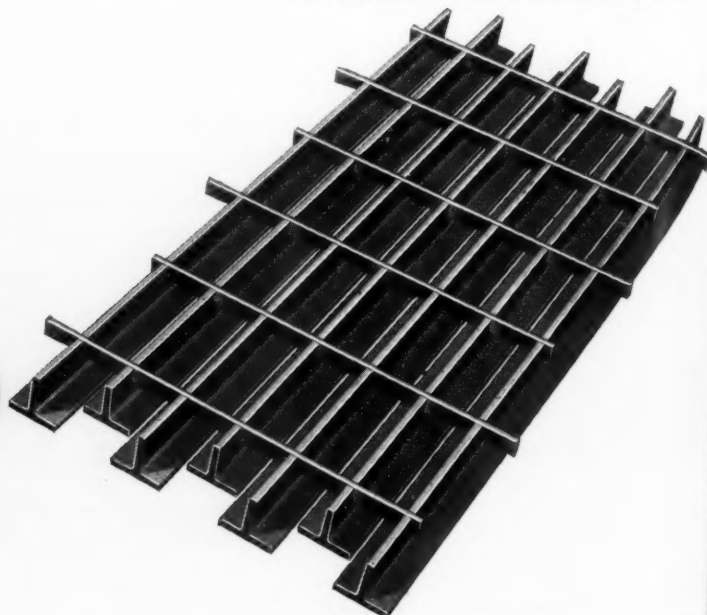
The Tri-Lok Co., Pittsburgh, Pa., has developed a new type of floor reinforcing for bridges, buildings, and similar structures, which is called Tri-Lok; T-Bar concrete armoring. With Tri-Lok, it is stated, the dead load of the entire structure is greatly reduced because the floor thickness is only one-third that of ordinary floor construction. The use of this armoring completely eliminates all concrete forms, since it is laid directly on the I-Beams and concrete poured. The edges of the bars produce a steel checkered surface which is said to last indefinitely and to be proof against chipping or cracking. According to the manufacturers, the material insures an integral floor construction, complete adhesion and a completely monolithic structure.

Take-Up Tie-Rod Clamps

The J. M. Willard Company, Los Angeles, Cal. have placed on the market a quick acting Take-up Bolt, which can be set up and locked with a hammer. It consists of three pieces of steel,—a bolt shank of any desired length, with case-hardened threads on one end and flattened



NOVO NH HOIST



TRI-LOK T-BAR ARMORING

for Economical Transportation

The New Utility Truck

*... the Lowest Priced Truck with
4 Speeds Forward ... 4-Wheel Brakes!*

Now Chevrolet presents the New Utility Truck—a low-priced haulage unit embodying every feature of advanced engineering developed through years of experience in commercial car building, and proved by exhaustive testing on the General Motors proving ground!

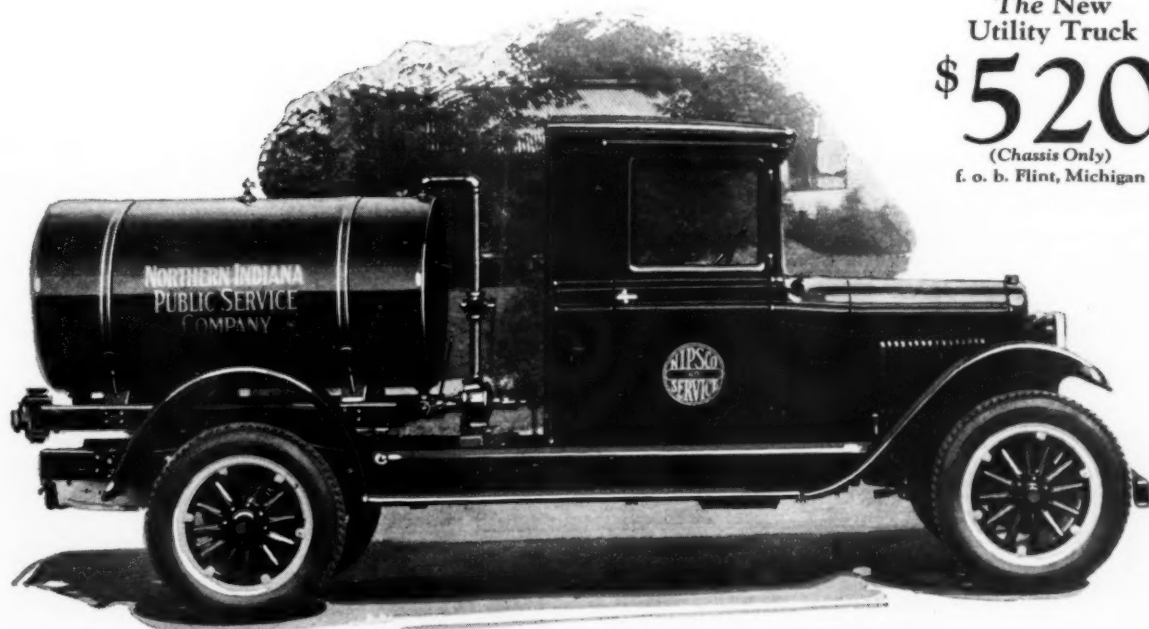
A new four-speed transmission, with an extra low gear, gives tremendous pulling power for heavy roads, deep sand and steep hills—and reduces to the very minimum the starting strain on motor, clutch

and rear axle! Powerful, non-locking 4-wheel brakes, with a separate emergency brake, give a new measure of safety and utility. And a new ball-bearing worm-and-gear steering mechanism provides handling ease never before experienced in a low-priced transportation unit.

Visit your Chevrolet dealer and get a demonstration of this remarkable new truck. There is a body type designed especially to meet the requirements of your business.

CHEVROLET MOTOR COMPANY, DETROIT, MICHIGAN
Division of General Motors Corporation

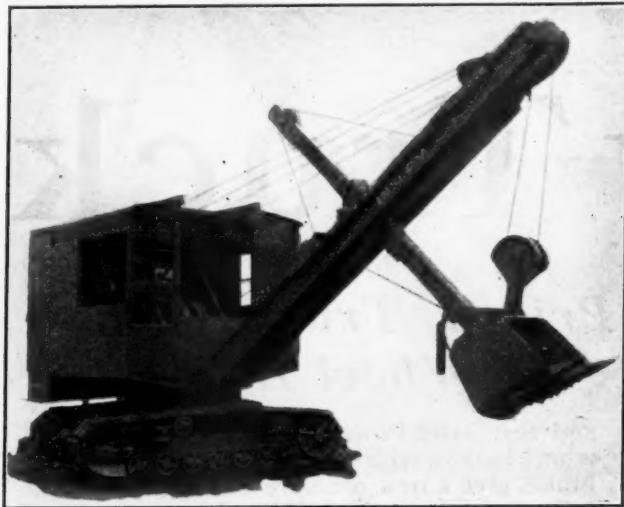
The New
Utility Truck
\$520
(Chassis Only)
f. o. b. Flint, Michigan



WORLD'S LARGEST BUILDER OF TRUCKS

on the opposite end, and punched to receive a wedge. Over the flattened end a punched washer-plate is slipped, and then the wedge is inserted and fastened so it cannot slip out. The three parts are thus locked together and while operating as a unit, cannot be lost.

A Bulldog Take-up Form Tie consists of a pair of take-up bolts, and two sleeve nuts. A sleeve nut on either end of a stud or tie-rod makes a form spacer.



INSLEY TYPE R EXCAVATOR

This is made up on the bench, and when placed between the form facings, receives a take-up bolt on each end, through the facings. The take-up bolts are screwed to place, using the loose wedges instead of a wrench, then tightened and locked by driving in the wedge. A hammer is the only tool required. A shoulder on the bolt shank will indicate to the inspector whether the bolt is properly home in the sleeve nut. When the wedges are driven in on either end, the facings will be held snugly to the walers, and the two sides will be held rigidly in their proper spacing.

After the concrete has been poured and has set, a blow from the hammer will release the wedges, which are then used to back the take-up bolts out of the sleeve nuts. This frees the form entirely, from the concrete, and it can be stripped in as large panels as convenient; and the panels

re-used. After stripping, the slotted head of the sleeve nuts will show up on the concrete surface. These are easily backed off from the tie-rods, (which are left in the concrete) by a special wrench. All sleeve nuts are lathe-finished, chamfered to receive the take-up bolts, and are cadmium plated to prevent rust either in the concrete or between jobs. Thus the immediate removal of the sleeve nuts is unnecessary. They

may be left in the concrete as long as convenient. The small clean holes left by the sleeve nuts are easily grouted.

Contractors using the Bulldog Take-up Tie state that two of these ties can be made up in the time required to make up one wire tie. Further, only one rod tie is required to replace three or four wire ties. From this as well as the paneling of forms, and re-use of the panels, a large saving of labor is effected.

Wherever surface rusting from the usual tie ends is undesirable, rod ties are especially valuable as the ends of the rods are left well in from the face of the concrete under the grouting, and no surface staining is possible.

Atlas 4-Wheel Drive Tractor

The Atlas Engineering Co., Clintonville, Wisc., manufacture a 4-wheel drive and 4-wheel steer tractor which is said to be designed and built primarily for all purpose road work. It is claimed to be very economical, the average fuel consumption as taken on two hundred working tractors being stated as 15 gallons of gasoline and $3\frac{1}{2}$ quarts of oil per ten-hour day. Power is furnished by a Waukesha 45 h. p. motor. Driving power is applied 15 inches from the center of the axle, and on all four wheels, developing ample draw-bar pull without excessive

weight. All driving gears are inclosed in oil. The front and rear wheels, wheel lugs, wheel bearings, gears and differential parts are interchangeable; all gears are machine cut. The patented self cleaning track shoe, provides two shoes on each wheel bearing at any period of revolution. The road load is 12 pounds per square inch.

Insley Type R Excavator

The Insley Manufacturing Company, Indianapolis, announces a new full revolving Insley excavator to be known as the Type "R." It is made with five attachments, the shovel, ditcher, skimmer, crane and dragline, all of which are interchangeable. The Insley Type "R" has many features of advanced design, including roller bearings for all shafts above the revolving frame, cut gears throughout, cast steel carbody, cast steel machinery base and side frames, separate control for each crawler, and one shot lubrication for crawler rollers. A special feature is the use of hydraulic brakes which operate separately on each crawler, and which are controlled from the operator's platform. These brakes operate as effectively in one direction as in the other, eliminating the necessity of dogs or chocks. Power can be applied to each crawler separately from the operator's platform.

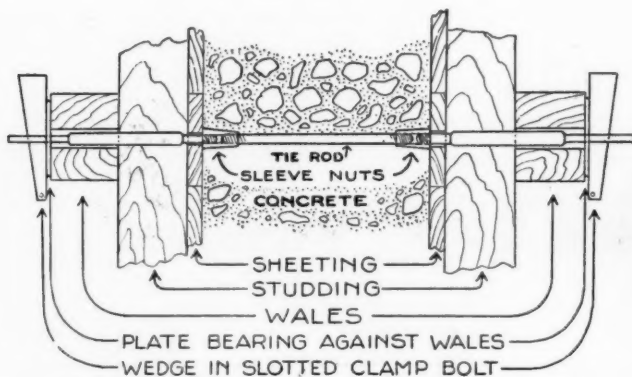
Another feature of the Insley is the swinging, which is 5 r. p. m., which combined with the line speed gives an exceptional operating speed. It has a tail swing of only 7 feet.

This shovel uses the Insley patented cable crowd. The standard shovel boom is 17'-6" long, giving a dumping clearance of 12'-6", or the shovel can be equipped with a high-lift boom and dipper for any clearance up to 15 or 16 feet. It has a gear driven power boom hoist which is self locking without the use of brakes or dogs.

The ditcher uses the same boom as the shovel, and has an effective digging depth of 18 feet.

The skimmer has a digging radius of 20'-6" from the center of rotation, a dumping clearance of 10 feet and carries a bucket with one-half yard working capacity.

The crane has a 35-foot boom as standard equipment, and can be equipped with



WILLARD TAKE-UP TIE ROD CLAMP



ATLAS TRACTOR




 The Mark
 of Quality

Taping leads to 125 h.p.
 —2300 Volt Booster
 pump motor—3 phase,
 at large power house.

The **SAFEST TAPE**— *is by far the most economical*

Give electricians and mechanics Firestone Friction Tape, with its greater strength and adhesion and unequalled insulating qualities, and several major items at factory costs can be kept under better control. Plant executives know that selecting the best tape is an important job—not from the small expenditure involved—but because so much de-

pends upon tape. Power must be conserved. Expensive equipment must be protected. With work like this to do, Firestone Friction Tape is the most economical you can buy: We invite inquiries from manufacturers and dealers regarding prices and discounts of shipments in bulk, or attractive resale cartons.

Firestone

FRICTION TAPE

AMERICANS SHOULD PRODUCE THEIR OWN RUBBER. . . *Harvey S. Firestone*

a longer boom if necessary. Its capacity is 5,200 pounds at 18-foot radius, 4,500 pounds at 20-foot radius, and 2,500 pounds at 30 feet. It has more than ample capacity to handle a one-half yard clamshell. The power boom hoist men-

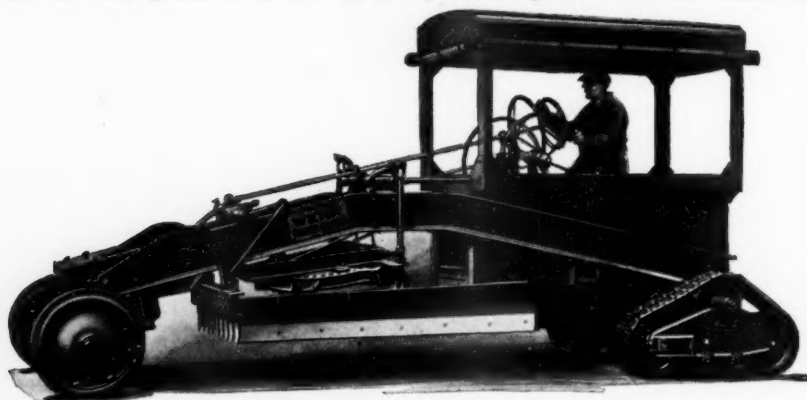
Form-Holds are stated to be very easy to use, it being necessary only to place them on the board, and crimp slightly so as to cling to the board; another board may then be placed on top, and the process repeated until the forms have

many of these units have been in service for several months.

Operation is controlled by a handy lever at the operators seat. This lever has three positions: Forward to lift, back to lower, and center neutral. At neutral the body is held firmly at any point and from any angle of elevation the body can be either raised or lowered. Automatic cut-offs stop motion at the highest angle, 55 degrees, and at riding position. The body can also be raised and lowered while the truck is in motion.

This hoist has automotive construction with alloy steel parts, machine cut gears, operating in oil in an oil tight gear case, bronze bushings, ball bearings and adjustments to 1/1000 inch tolerance. Double bevel gears and worm gearing are used in power transmission.

A most important feature is the hoisting device itself. This is an articulated rack, with teeth which mesh into the final spur gear drive. Twenty-three sections held together by 5/8" pins with riveted heads make up this rack. As the body is lowered the extra length of the rack curves back into a dust tight case. In this direction the rack is very flexible but when in hoisting position, slightly curved, the rack is rigid and strong



WEHR POWER GRADER MODEL T-2

tioned is of great value on crane work as the boom can be raised and lowered under a load.

The dragline uses the same boom as the crane, and a bucket having a half yard working capacity.

Wehr Power Grader

The Wehr Co., Milwaukee, Wisc., has developed a one-man grader, model T-2, for use with the McCormick-Deering power unit. The T-2 has 10-inch channel side members, which are formed into a rigid unit by ten heavy cross members. The circle is a solid unit cast from high carbon steel, and accurately machined. The blade beams are exceptionally heavy and blade control is accomplished through machine cut gears enclosed in oil tight housings. Lifting is made extremely easy by the dual spring lifting device. The lifting arms are of a new ball and socket design, which can be adjusted with a wrench. Steering is accomplished with a worm and lever type Hannum steering gear.

The operator's position is such that he can see the moldboard and tractor at all times. The operator is fully protected from the weather, and the compartment can be closed with curtains.

The model T-2 can be furnished with an independent scarifier, or with a scarifier attached to the circle, in which position it can do much heavier work. The independent scarifier is controlled by a hand wheel, and can be raised 14 inches from the ground. The scarifier is built with drop forged chrome nickel teeth, which are easily removable, though held very rigid.

"Form-Holds"

The Concrete Form-Hold Corporation, Culver City, Calif., has brought out "Form-Hold," which is a one-piece reversible sheet metal device for tying and spacing forms. These devices are notched to receive the form boards and reinforcing. The outer notches tie and space the form board; the center notches hold the reinforcing steel in place, and also act as vents thereby preventing the formation of voids in the wall.

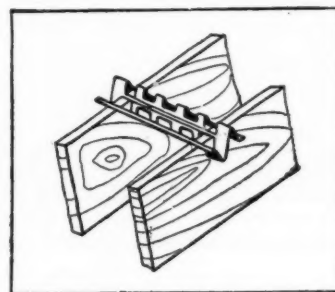
been placed. Each Form-Hold is constructed to withstand the normal pressure of fluid concrete against 288 square inches of form surface.

By the use of these devices, it is claimed, each board is held firmly in place, and all wiring and spacer blocks are eliminated, and labor costs greatly reduced. Studs can be placed at 4 to 6-foot intervals, and are needed on only one side of the wall. After the concrete has set, by bending up one row of projecting ends of the Form-Holds, forms can be removed easily and in good condition. The short projecting ends of Form-Holds that project beyond the concrete can be cut off with a spading tool or straight hoe.

Since these devices act equally well on tension or compression, they may be used under water. They are also excellent for tying brick veneer to concrete, in hollow wall construction, and for furring for metal lath.

New Hercules Ditwiler Power Dump Body

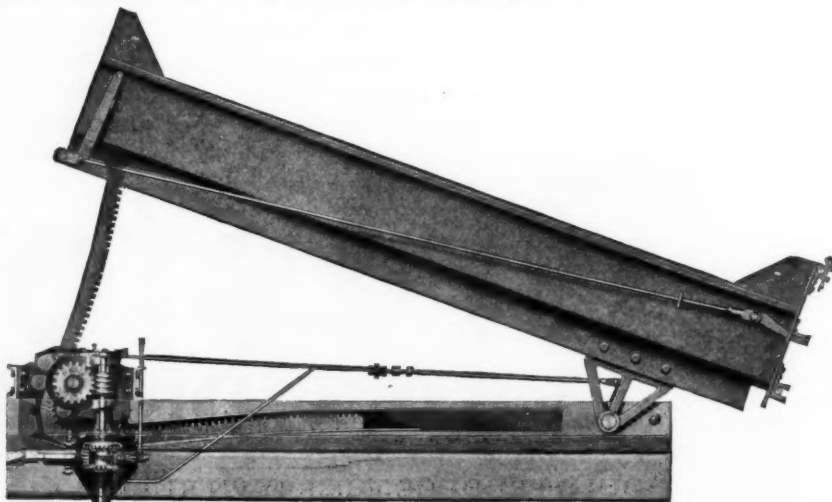
The Ditwiler Manufacturing Co., Galion, O., has just announced a power dump body with a hoist operated by a new and unusual principle, although



FORM HOLD

enough to carry twice the load it will ever be called upon to carry with light or medium weight trucks.

The Ditwiler unit of installation on the Chevrolet chassis is being marketed through Hercules Products Inc., Evansville, Ind., and their 71 distributors throughout the United States; and through the Warford Corporation in Canada.



DITWILER HERCULES DUMP BODY

PRESTIGE BUILT BY PERFORMANCE



When you buy an M-W "AIR KING" you buy the utmost in Portable Air Compressor ability. You buy a machine that is always ready for work—under any and all operating conditions—under any service you may demand of it.

Designed and built by engineers who know what is most needed in Air Compressors, the "AIR KING" is a machine you can purchase with confidence and operate with satisfaction. Displacing from 5 to 50 men, the "AIR KING" introduces unbelievable economy over a period of years—a fact proven by the

largest public utility companies in the United States.

Outstanding features—its internationally proven Worthington Air Compressor; its famous Laidlaw Feather Valves; its powerful Wisconsin Engine—stamp the "AIR KING" as a machine whose quality is as dominant as its rugged performance.

The "AIR KING" is made in 110, 210, 280 and 330 cu. ft. sizes—in "Towabout," Railcar and other suitable mountings. A fully illustrated catalog complete with mechanical details is yours for the asking.

(P. S.—The City of Philadelphia now own and operate seven M-W Compressors).

METALWELD, Inc.

26th & Hunting Park Ave., Phila., Pa.

Dealers in all principal cities



Metalweld-Worthington *Portable Air Compressors*

CIVIL SERVICE

Assistant in Engineering Information.

—Applications for assistant in engineering information must be on file with the Civil Service Commission at Washington, D. C., not later than August 15. The examination is to fill vacancies in the Bureau of Public Roads, Department of Agriculture, Washington, D. C. The entrance salary for this position is \$2,600 a year. Higher-salaried positions are filled through promotion. The duties are to write for the press original articles on the engineering and economic researches of the Bureau, based on technical reports and interviews with scientists, economists, and engineers in charge of investigations; to prepare articles for technical magazines, encyclopedias, and other publications on road building and maintenance, and highway administration and finance. Competitors will not be required to report for examination at any place, but will be rated on their education, and experience, and published papers or magazine or newspaper articles prepared by the applicant (to be filed with the application).

Associate Construction Engineer.

Applications for associate construction engineers must be on file with the Civil Service Commission, at Washington, D. C., not later than August 15. The examination is to fill vacancies in the Office of the Supervising Architect, Treasury Department, for duty in Washington, D. C., or in the field. The entrance salary for this position is \$3,200 a year. Higher-salaried positions are filled through promotion. Competitors will not be required to report for examinations at any place, but will be rated on their education, training and experience.

Architectural, Construction, Electrical, Mechanical and Structural Engineers.

Applications for these positions must be on file with the Civil Service Commission at Washington, D. C., not later than August 15. The examinations are to fill vacancies in the Office of the Supervising Architect, Treasury Department, for duty in Washington, D. C., or in the field. The entrance salaries are \$2,600 a year for the assistant grade, and \$3,200 a year for the associate grade. Higher-salaried positions are filled through promotion. Competitors will not be required to report for examination at any place, but will be rated on their education, training, and experience.

Junior Chemist.—Applications for junior chemist must be on file with the Civil Service Commission at Washington, D. C., not later than September 4. The examination is to fill vacancies in the Federal classified service in Washington, D. C., and in the field. The entrance salary for this position is \$2,000. Higher-salaried positions are filled through promotion. The duties are in connection with different phases of chemistry, chemical engineering, and industrial technology. The facilities of the different bureaus make them in many respects the

best equipped laboratories in the world, and close contact with the industries make the experience thus obtained ideal preparation and training for industrial research. Chemists who desire to continue college work are offered good opportunities to do so, not only in the universities in Washington, which arrange their class hours to suit the convenience of persons in the Government service by giving courses in most subjects in late afternoon or evening, but, in addition, the departments themselves, in a number of cases, offer courses in advanced work which are given suitable credit by recognized colleges. Competitors will be rated on general chemistry and elementary physics, and an optional subject. The optional subjects are: Advanced inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry.

Instrument Maker.—Applications for principal instrument maker, senior instrument maker, and instrument maker must be on file with the Civil Service Commission at Washington, D. C., not later than August 22. The examination is to fill vacancies in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., or in the field. The entrance salaries for these positions range from \$1,440 to \$2,000 a year. Higher-salaried positions are filled through promotion. The duties are to design, construct, and repair scientific and technical instruments and apparatus of high precision. The relative responsibility of the work involved will vary according to the grade of the position, the higher-salaried grades embracing duties of difficulty and responsibility. Competitors will not be required to report for examination at any place, but will be rated on their education, training, and experience.

Information.—Full information concerning the above positions may be obtained from the United States Civil Service Commission at Washington, D. C., or from the secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city.

INDUSTRIAL NOTES

The Link-Belt Co., Chicago, Ill., publishes "Shovel News," which contains interesting illustrated accounts of Link-Belt Shovels on various jobs.

The new Chicago office of the C. O. Bartlett & Snow Co., of Cleveland, is located at 505 First National Bank Building and is being managed by S. G. Artingstall, Jr.

F. W. Sampson has been appointed engineer in charge of the shock absorber Division, Continental Motor Corporation.

Appointment of F. L. Stone as general sales manager of the Universal Portland Cement Co. has been announced by B. F. Affleck, president. Mr. Stone succeeds Blaine S. Smith who recently resigned to become president of the Pennsylvania-Dixie Cement Corporation.

The Jaeger Machine Co., Columbus, O., has announced the sale of 85 Jaeger mixers to the French government of these machines; 50 were the 14-S, ½-yard model. Recently two carloads were ordered by the Russian government.

Louis Garbi has been appointed consulting engineer for the Western Amiesite Asphalt Co. and its licensees and clients.

The merger of the Construction Machinery Co. of Waterloo, Ia., and the Marsh-Capron Co. of Chicago has been announced. The consolidated business will be carried in the name of the Construction Machinery Company.

Sweet's Steel Co., Williamsport, Pa., announce the appointment of Silas M. Haight as manager of their research department, and Samuel C. Robman as manager of sales in the anthracite district, with headquarters at Wilkes-Barre.

Orders for Indiana Trucks received by the Indiana Truck Corporation at Marion, Indiana, during the first six months of this year show an increase of forty-five per cent over the first six months of last year. Orders for July continue to show an increase.

The Young Radiator Company, Racine, Wisconsin, has received a one year contract from the Chicago Pneumatic Tool Company, with plants at Franklin, Cleveland and Detroit, for the manufacture of radiators for portable compressors.

Controlling interest in the National Cast Iron Pipe Co., Birmingham, Ala., has been acquired by James B. Clow & Sons, Chicago.

The Heil Co., Milwaukee, Wis., has announced the consolidation of that company with the Hydro Hoist Co., a subsidiary. C. C. Smith is chairman of the board of directors of the consolidated company. J. P. Heil, formerly vice president and treasurer of the Heil Co., has been elected president and treasurer, Herman W. Falk, vice president and W. N. Chester, secretary. The board of directors consists of the officers and George P. Miller and Wm. G. Thwaites.

The southeastern sales office of W. S. Dickey Clay Mfg. Co. has moved into the Candler Building, Atlanta, Ga. Sales work heretofore handled at Chattanooga and Macon will be concentrated in the Atlanta office. Office personnel includes Clif. B. Beasley, Southeastern Sales Manager, recently at Birmingham, Arthur G. Brading, formerly at Chattanooga, Henry C. Davis, from Macon, and others. Territory served from the new office includes Kentucky, Tennessee, Virginia, North Carolina, South Carolina, Georgia and peninsular Florida. Customers who heretofore have directed mail to Chattanooga or Macon are requested to address orders or inquiries to W. S. Dickey Clay Mfg. Co., 1302 Candler Building, Atlanta, Ga.